CANADA AGRICULTURE

FALL '70/AUTOMNE 70

CANADA AGRICULTURE

VOLUME 15 FALL 1970 NO. 4
VOLUME 15 AUTOMNE 1970 N° 4

JOURNAL OF THE CANADA DEPARTMENT OF AGRICULTURE—OTTAWA
REVUE DU MINISTĒRE DE L'AGRICULTURE DU CANADA—OTTAWA
MINISTER, HON. H. A. OLSON, MINISTRE DEPUTY MINISTER, S. B. WILLIAMS, SOUS-MINISTRE

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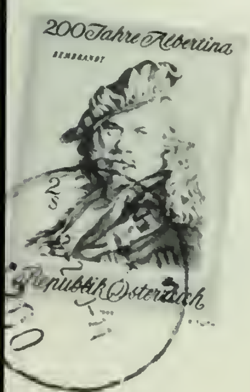

THE EUROPEAN CORN BORER GOES INTERNATIONAL

MARCEL HUDON

> Le Canada participe depuis 1969 à une expérience internationale sur la pyrale du maïs avec les pays suivants: U.S.A., France, Espagne, Autriche, Pologne, Hongrie, Roumanie, Yougoslavie et Russie. Cette étude a pour but de déterminer la survivance de diverses populations de pyrales du maïs sur 40 lignées de ce graminée dans des conditions écologiques différentes. Le même protocole concernant les méthodes utilisées et le dispositif expérimental doit être respecté dans chacun de ces pays. C'est probablement la première fois dans toute l'histoire de l'entomologie qu'une expérience scientifique du genre est entreprise.

Indian corn or maize, *Zea mays* L., has been cultivated for thousands of years. When the New World was discovered, it was being grown in many parts of Central and South America. Corn is one of the most important cereal crops in the world. In Canada, consumption of grain corn has increased considerably since World War II, mainly because of hybrid varieties adapted to shorter growing seasons. With increased corn acreage in Canada, the European corn borer, *Ostrinia nubilalis* (Hbn.), and its control is becoming more important.

The European corn borer is a worldwide problem. During the 13th International Congress of Entomology held in Moscow in August 1968, Dr. D. Hadžistević of Yugoslavia convened a group of European entomologists working on *Ostrinia*, and asked Dr. H. C. Chiang of the University of Minnesota to discuss the genetical research work on the insect. This group which consisted of entomologists from Hungary, Poland, Rumania, USSR, USA, and Yugoslavia, responded with great interest, and decided to start an international cooperative project to study the responses of the European corn borer on different inbred lines of dent corn of different geographical origins. Contacts by correspondence after the Moscow Congress enlarged the group to include entomologists from Austria, Canada, France and Spain. It was agreed that the experiment, materials, methods and sampling procedures would be identical in each of the 10 countries to facilitate the analyses and interpretations of the results obtained. This international experiment would be the first of that nature in the history of entomology.

The Canadian part of the experiment is being carried out at the CDA Research Station, St. Jean, Que. Corn for grain and silage has become increasingly popular in Canada with the adoption of earlier maturing and higher yielding hybrids. In Quebec, almost 140,000 acres of grain and silage corn were produced in 1969, an increase of 19 percent over the previous year. In this province, the corn borer is the worst pest of corn causing appreciable losses.

In Quebec, the corn borer has only one generation per year whereas it has two generations in southern Ontario. The damage (borings and tunnels) caused by the mature larvae in the stalks and ear shanks is more pronounced in Quebec than in areas where two-brood are reared because the mature larvae re-

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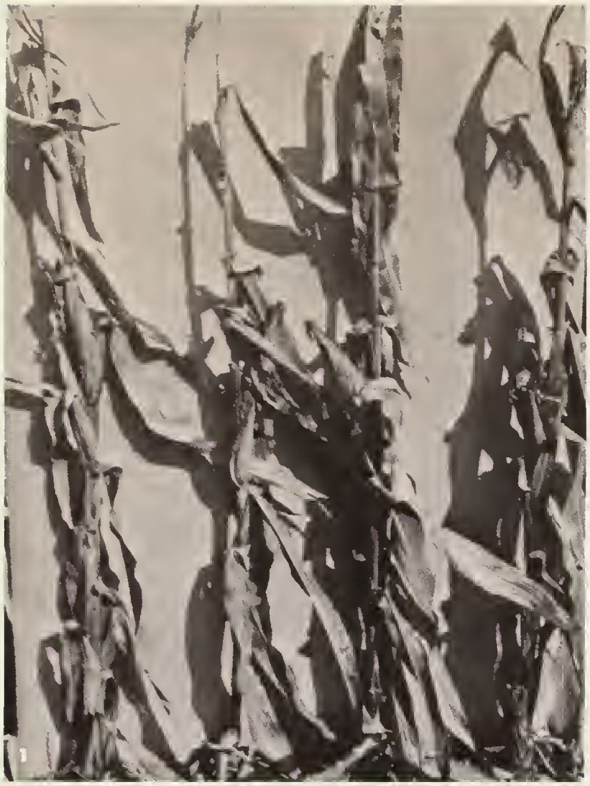


main active over a longer period. The use of hybrid corn varieties has helped reduce these losses.

The objective of the cooperative project is primarily to determine the survival of the European corn borer populations on a number of inbred lines of maize at stations located in the ten countries and to determine the extent and type of injury inflicted on the host plant.

The information obtained from the ten countries may explain the evolution of corn borer populations in different climates and its adaptation to various inbred lines of corn. It may also provide, with the exchange of a variety of inbred lines, an opportunity to find some useful germ plasms overlooked before, because of different growing conditions. Furthermore, differences in corn borer/corn yield relationships, in various parts of the world, may be explained by studying the ability of different corn borer populations to inflict plant damage. Finally, the information on the reproductive capacity of the moths reared on each inbred may explain the long-term influence of host resistance to borer populations.

Each cooperating country has selected four inbred lines of dent corn of different native resistance ratings to survival of (1) the first and second larval instars, (as expressed by feeding damage to the leaf blade in the whorl stage of development) and (2) their degree of resistance to the third and fourth larval instars, (as expressed by feeding lesions on the leaves). The inbred lines representing Canada were supplied by Dr. H. C. Chiang of the University of Minnesota. The 40 inbreds ranged from very resistant, resistant, susceptible to very susceptible to corn borer infestation, and possessed different degrees of earliness. Two hundred seeds of each inbred line were sent to each cooperating country (of possible 3000 plants in test plots, 2400 were studied). All inbreds were subjected to four different intensities of borer infestation which were established by (1) the natural population of the insect, (2) DDT treated to eliminate as much natural infestation as possible, (3) naturally infested plus two egg masses, and (4) naturally infested plus four manually applied egg masses per plant. A month after infestation, each plant of the infested group was rated individually for amount of leaf feeding present to determine resistance.

Dissection of the four groups was made in August and September, recording the number of live and dead borers, number of cavities in the stalks and various sites on the plants where borers were found. Yield data were obtained for plants that were highly artificially infested and naturally infested, from the weight of the ears in each plot recorded as fresh ear, dry and shelled corn.

A relatively high natural corn borer population prevailed in 1969. This resulted in important differences in the rate of borer establishment and survival in different inbred lines (Fig. 2). Thus, after only one year's study, a trend in inbred performance became quite obvious. The degree of resistance and susceptibility to the corn borer exhibited by some inbreds is shown in Fig. 3. All the 40 inbred lines from the ten cooperating countries grew and matured very well under climatic conditions at the CDA Research Station, St. Jean, Que., and responded favorably to the four different population densities.

The results obtained in 1969 gave a preliminary picture for the evaluation of the extent and type of injury inflicted on host plants by: percent borer survival, leaf feeding and plant damage ratings, number of cavities per plant, maturity and yields. In such a study, it is very important to have a high level

Fig. 1 The resistant line France F574: plants of the heavily infested group. L'Acadie, Que., 1969.

Fig. 2 The high degree of larval establishment and damage exhibited by a susceptible inbred line. L'Acadie, Que., 1969.

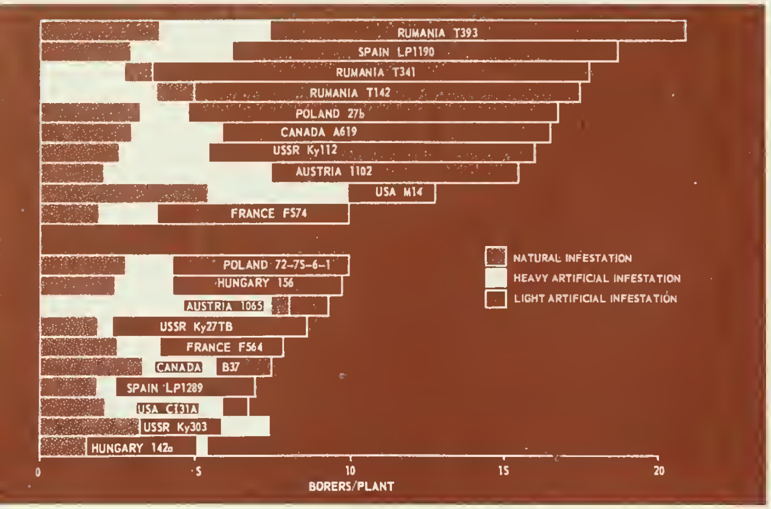
Fig. 3 The susceptible line USSR Ky27TB: plants of the heavily infested group. L'Acadie, Que., 1969.

Fig. 4 The European corn borer is the most destructive insect of corn in Quebec.

COOPERATORS IN THE EUROPEAN CORN BORER PROJECT

Austria	Dr. W. Faber
France	Dr. P. Anglade
Hungary	Drs. B. Dolinka and B. Nagy*
Poland	Dr. Czeslaw Kania
Rumania	Drs. T. Perju and D. Mustea*
Spain	Dr. A. Monteagudo
U.S.A.	Dr. H. C. Chiang (coordinator 1969)*
U.S.S.R.	Drs. I. D. Shapiro, G. B. Sheura-Bura* and G. S. Galeew*
Yugoslavia	Dr. D. Hadzistevic (coordinator 1970)
West Germany	Dr. H. Kostlin (consultant on insecticides)

*Cooperating in the project.



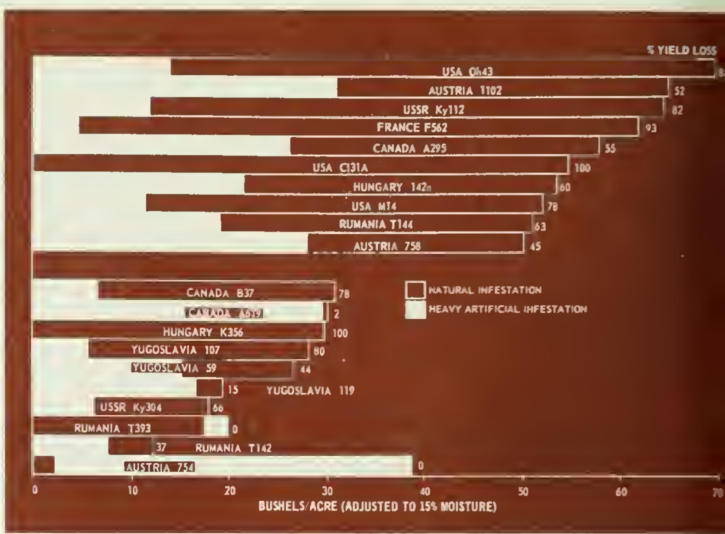


Fig. 5 Yields obtained in the most and least productive inbred lines of dent corn. L'Acadie, Que., 1969 (above).

Fig. 6 European corn borer survival in susceptible and resistant dent corn inbred lines. L'Acadie, Que., 1969 (right).

of larval establishment and survival to obtain a trend in inbred performance and an expression of the resistance factor that may exist. The inbred line Rumania T393 (20.9 larvae per plant) followed by Spain LP1190 (18.7 borers per plant) harbored the greatest populations 20 days after egg hatch and more than the recognized American susceptible line WF9 with 13.7 borers per plant. Also, Hungary 142a (5.1 borers per plant) and U.S.S.R. Ky303 (5.8 borers per plant) harbored the smallest populations and less than the well known American resistant lines C131A with 6.8 borers and Oh43 with 12.5 borers per plant. As it was observed, elsewhere, most of the mortality of the borers did occur within a few days after egg hatch. The mean larval population of all lines decreased appreciably between 20 (light artificial infestation) and 60 days after egg hatch (heavy artificial infestation) from 12.1 to 5.2 borers per plant; however, the mean number of cavities in the stalks between those two groups had increased from 3.4 to 17.3 holes per plant. Of the 40 inbreds tested, 30 percent were considered rather *resistant*, 50 percent *intermediate* and 20 percent were considered *susceptible* to the corn borer. Some inbred lines, like Rumania T341 and T142, had very high larval populations 20 days after egg hatch, but the populations in these inbreds decreased and 60 days after egg hatch, in the heavy artificial infestation group, the populations were at a very low level. However, some lines, like Hungary 142a and U.S.S.R. Ky303 had the lowest larval populations 20 days after egg hatch, but in the heavy artificial infestation group, the populations remained at a rather high level.

The results show that the number of larvae, surviving 60 days after egg hatch, may be a good index of inbred performance for some lines, but not for all inbreds, since a decrease in yield is not always related to the number of borers found in the plants at harvest. The reduced yields observed in some lines (Fig. 5) seem to be more related to the early infestations or at the time of leaf feeding damage of the plants that would retard the growth of the plants and have an effect on the yield. The yield of naturally infested plants, adjusted to 15 percent moisture, ranged from 2.4 bushels per acre (Austria Nr754) to 69.6 bushels per acre (USA Oh43) and the mean of all inbreds tested was 39.2 bushels per acre.

One of the purposes of the experiment is to find out if a recognized resistant line in its country of origin would maintain its resistance in other cooperating countries. This is well illustrated with the inbred France F574, resistant in France, which has maintained its resistance in Canada (Fig. 1) with only 1.9 borers per plant (natural infestation) and 3.8 borers per plant (heavy artificial infestation). Also, the inbred U.S.S.R. Ky27TB, susceptible in Russia, has maintained its suceptibility (Fig. 3) to stalk breakage, even with only 2.3 borers per plant (natural infestation) and 1.9 borers per plant (heavy artificial infestation). However, some inbred lines (Hungary 156) rated very susceptible in their native country did not sustain a high borer population from natural and artificial infestations in Canada; also, some inbred lines (USSR Ky112 and Rumania T393), rated resistant in their native country, were very susceptible to the borer in Canada.

It is also important to point out that, in addition to the purely scientific merit of this endeavor, a project of this sort provides the entomologists of ten countries an occasion of working together as scientists at an international level. ■

CDA LIBRARY SERVING NATION'S RESEARCH

SCOTT HATFIELD

Au cours des soixante dernières années, la bibliothèque du ministère de l'Agriculture a utilisé diverses techniques de bibliothéconomie pour fournir aux intéressés, savants, scientifiques et chercheurs, des renseignements scientifiques dont ils ont besoin. L'une des plus récentes est le service canadien de dissémination sélective d'informations appelé communément CAN/DSI.

Those who think of a library as a building nestled drowsily in a landscape of shrubbery are surprised to find that it can be affected by events around the world. It is true that libraries preserve the records and historical documents that lend perspective to the present. That goes without saying. But who would ever think that when designers alter hemlines, library telephones ring with questions on how minis or maxis will relate to world conditions, the possible effects on the textile industry and on wages of factory workers . . .

It is not surprising, then, that a library situated in the nation's capital and serving a substantial part of the nation's research needs for 60 years, should feel the impact of changes around the world affecting the parent industry of the country—agriculture.

"This year marks the Diamond Anniversary of the Canada Department of Agriculture (CDA) Library," says Mrs. Peggy Reynolds, Chief Librarian.

"Few people realize that the modern library relates to the national and international scene. The resources of our library are drawn on internationally by scholars, scientists and other researchers representing a wide range of disciplines", she says.

In 60 years the CDA Library service has developed from the humble beginnings of a small office collection and a staff of one in 1910 to a network of libraries spanning the nation from coast to coast and serving the needs of Canada's agricultural community as a

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The CDA headquarters library is located in the Sir John Carling Building, Ottawa.

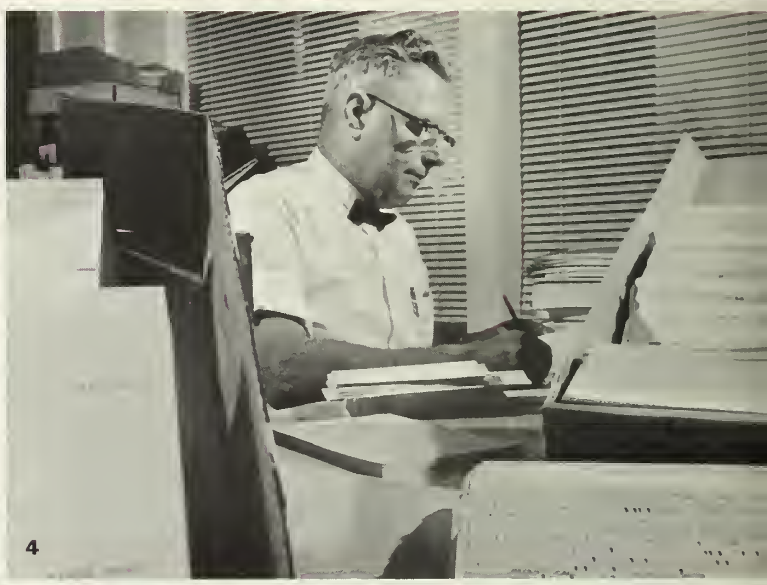
Fig. 1. A librarian at headquarters scans a completed set of catalog cards made from paper tapes on automatic typewriters.

Fig. 2 A SDI print-out directs a scientist to key information in his field of interest. SDI is a computerized library service being used increasingly by scientists in the Canada Department of Agriculture.

Fig. 3 A cataloguing clerk at the main library makes copies of entries from Library of Congress printed catalogue – to send to correct cataloguing information to a branch library.

Fir. 4 A member of headquarters library staff working on automatic circulation of periodicals which are sent to CDA personnel across Canada. He is preparing data processing forms in anticipation of upcoming journals that will be received by the library.

Fig. 5 Even Friday afternoon can be busy in the branch libraries, as witnessed at the CDA Research Station library in Winnipeg. The Winnipeg library is one of 23 branch libraries serving the regional needs of Canada's diverse agricultural community.



whole. Today there is a staff of over 100, half of which is at the headquarters library located in the new Sir John Carling Building on the Central Experimental Farm in Ottawa. There are about 350,000 volumes in the main library with another 10,000 to 15,000 in each of the 21 branch libraries. The branch and field libraries co-operate with university and provincial networks by providing special services such as a computerized grasshopper index (for counting grasshoppers in the prairies) in Saskatoon and coordinate indexing services in Vancouver and Winnipeg.

No matter where CDA staff are located the library serves them in their work. This encompasses about 11,000 people in various occupations such as research scientists in many disciplines, economists, statisticians, veterinarians, inspectors, editors, technicians, home economists and so on.

The library has amassed one of the foremost collections in agriculture and allied sciences—botany, chemistry, animal husbandry, entomology, veterinary medicine, biology, agricultural engineering, rural sociology, food and nutrition, soils and fertilizers, and the marketing, transportation and other economic aspects of agricultural production. In the main library there are several special collections including depository publications of the Food and Agriculture Organization, the United States Department of Agriculture and State Experimental Stations and the Commonwealth Agricultural Bureaux.

THE INFORMATION EXPLOSION

Of great impact on the library has been the information explosion of the past two decades. The rate of increase of information generated has become so great that a young scientist starting out now and looking back at the end of his career will find that 80 to 90 per cent of all scientific achievement will have taken place before his very eyes, and that only 10 to 20 per cent of scientific discovery will antedate his experience. An equally compelling observation is one made by Simon Pasternak in *Physics Today* (Vol. 19. No. 38). He finds that, in three fields closely related to modern agriculture—biology, chemistry and engineering it will require studying 1,000 articles a day just to keep up with developments in a specialized field. The day of the general scientist has ended. But the day of providing accessibility to this volume of information has just begun.

The CDA Library recognized this trend and pressed for modernization of traditional library techniques as early as the 1950's. In 1954 automation of services was started when circulation control of current periodicals and Departmental subscriptions to periodicals were converted to punched cards. They have since been fully computerized. In the process of being computerized are some 30,000 journal and other serial titles—a mammoth undertaking.

One of the latest developments in computerized library services is a system known as Selective Dissemination of Information or simply SDI. Mrs. Reynolds says that all libraries have access to SDI tapes provided through the Canadian or CAN/SDI project of the National Science Library, National Research Council.

In the Department of Agriculture SDI is used mainly by research scientists. One user discussed his experience in using the system since it was introduced earlier this year. Dr. C. Madhosingh, a biochemist with the Cell Biology Research Institute in Ottawa finds that the system helps him in his specialized field of interest—tyrosinase isoenzymes in plant pathogenic fungi.

"Research," he says, "is a frontier area in science and the prompt communication of knowledge is vital. Rapid communication not only eliminates any possibility of repetition of similar work but increases national and international efficiency in research.

"SDI not only provides information quickly it also provides, selectively and analytically, a search for relatively specific information from an increasingly large volume of scientific literature. Without SDI it would be impractical to obtain this information."

To use the service, librarians work closely with scientists in designing interest profiles related to a scientist's particular research project. The quality of the interest profiles determines feedback and their design requires a knowledge of and skill with the terminology used in a particular field. The library has on staff an SDI specialist for this purpose. The object is to retrieve maximum relevant information with as little irrelevant 'noise' as possible. Computer feedback or 'print out' relevancy has been as high as 91.3 per cent and as low as 10 per cent, depending largely upon the specific terminology of a particular field of interest. The Cell Biology Research Institute was the first to use this new service in CDA but most of the other research institutes and research services are either using it now or are in the process of subscribing to it.

Experience with SDI has suggested various benefits. One of these is the critical timing of an important reference. Dr. Madhosingh recently found that timing worked to his advantage in the communication of research results: "I obtained key information only a few days before presentation of a paper at an international conference. This information not only improved discussion in the paper but gave me the opportunity to assert our pre-eminence in a specialized field, since we were made aware of significantly new information."

Libraries, then, operate in an increasingly sophisticated world of user-oriented information storage and retrieval. They are at the center of the information explosion and feel the impact of change. Sensitive as they may be to all types of events around the world, it can be seen that when library telephones ring it is not always about mini-skirts. ■

LA TACHE STEMPHYLIENNE DU TREFLE ROUGE AU QUEBEC

CAMILIEN GAGNON et CLAUDE AUBÉ

The authors study crop loss caused by stemphylim leaf spot, common in Quebec, and the effects on the root system by the two species of this soil fungus.

Le trèfle rouge, *(Trifolium pratense L.)*, est la légumineuse fourragère la plus courante au Québec. Les cultivateurs du Québec la préfèrent à la luzerne dont les essais d'établissement ont malheureusement trop souvent abouti à des échecs. Le trèfle rouge s'établit assez facilement dans la plupart de nos sols.

Malgré que le trèfle rouge soit une plante vivace, sa persistance est très courte. Il faut voir là les effets de la rigueur du climat et de nombreuses maladies. Parmi les maladies, les pourritures des racines sont sans doute celles qui contribuent le plus à réduire directement sa persistance. Cependant, il ne faut pas pour autant négliger les maladies du feuillage qui contribuent indirectement à réduire la persistance. Ceci a été démontré pour la tache stemphylienne sur le trèfle rouge. Monsieur Claude Aubé a déjà rapporté ailleurs que cette maladie est la plus fréquente des maladies foliaires du trèfle rouge au Québec. Nous essayons actuellement de déterminer les pertes directes causées par cette maladie tant dans le rendement que dans la qualité des fourrages.

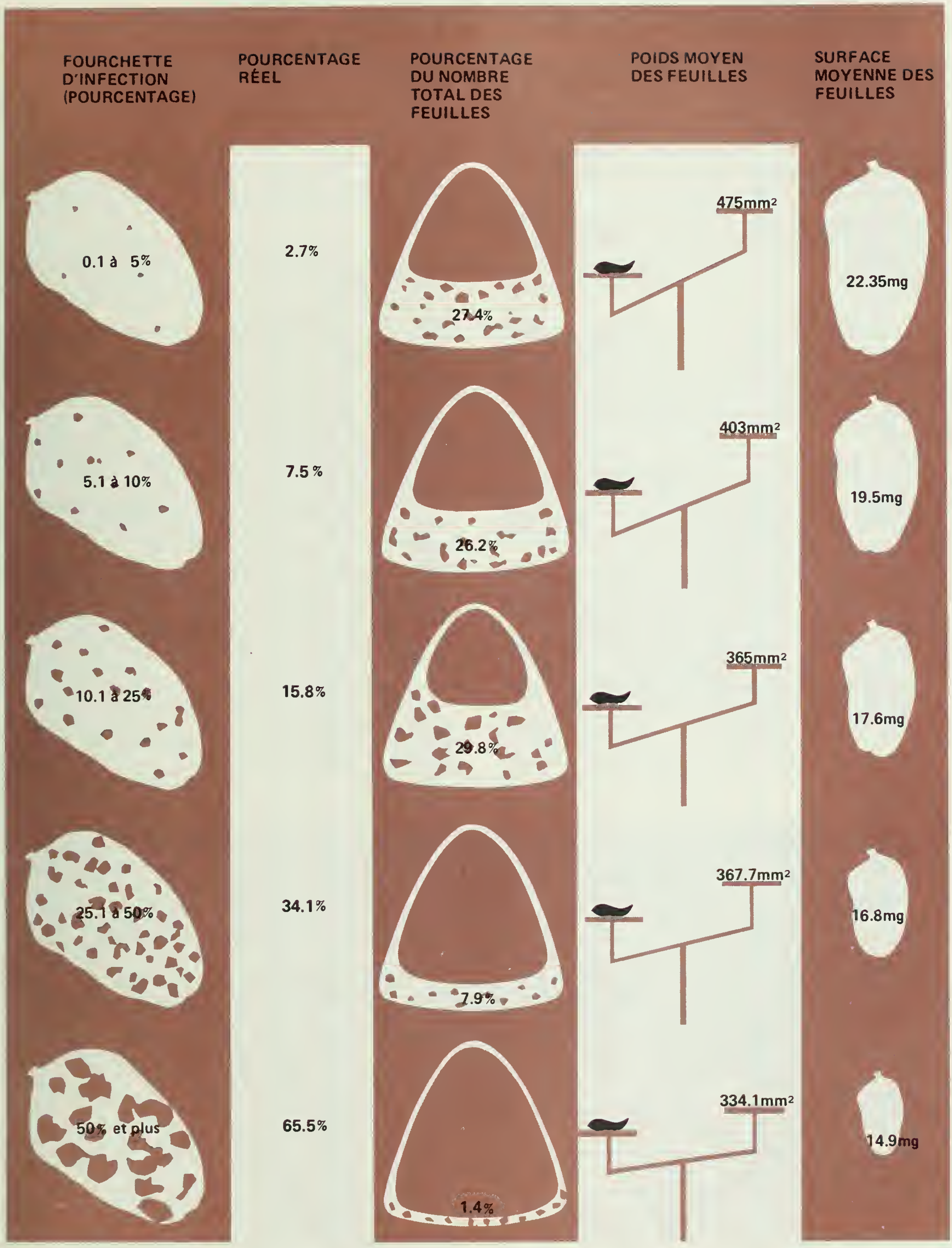
Cette maladie, causée par un champignon appelé *stemphylium sarcinaeforme*, se présente surtout sur les feuilles mais s'attaque également aux tiges. Quand l'infection est légère, on peut voir sur les feuilles de petites taches rondes ou ovales d'environ ⅛ de pouce de diamètre. Souvent le centre est composé d'un point brun foncé avec un ou deux cercles concentriques. Dans les cas d'infection sévère les taches se fondent ensemble, tuant de larges portions de feuilles qui brunissent, se recroquevillent et tombent. Un autre champignon du même genre, *S. botryosum*, cause également des taches sur le feuillage mais leur contour est beaucoup plus irrégulier.

Taches stemphyliennes sur folioles de trèfle rouge.

Afin de déterminer les pertes causées par la tache stemphylienne, une première étude fut effectuée au cours de l'été de 1969 sur sept champs répartis entre Trois-Rivières et La Pocatière. Sur les 3,179 folioles prélevées et étudiées, 232 c'est-à-dire 7.3% seulement ne montraient aucune maladie. Ces feuilles avaient une surface moyenne de 487 mm. carré et pesaient 21.6 mg. Sur le tableau ci-dessous nous constatons que la surface et le poids des folioles diminuent à mesure que s'accroît le pourcentage de la surface couverte par des taches stemphyliennes. On remarque également que le nombre de taches par foliole s'accroît avec l'intensité de la maladie jusqu'au seuil de 50% où le nombre de taches diminue mais où la surface de celle-ci augmente en raison de la fusion de plusieurs taches ensemble.

Nos observations ont également établi que les racines des plants infectés par la tache stemphylienne ou la rouille étaient plus fréquemment atteint de pourriture que les plants ne présentant pas de maladie foliaire. Il semble opportun d'étudier le rôle du stemphylium dans la susceptibilité des racines aux attaques par les micro-organismes du sol. Ces travaux pourraient servir à orienter un programme d'amélioration du trèfle rouge en vue de développer des variétés plus persistantes. ■

MM. Gagnon et Aubé sont des phytopathologistes, spécialistes des maladies des plantes fourragères à la station de recherche du ministère de l'Agriculture à l'université Laval, Sainte-Foy, Québec 10.


FOURCHETTE D'INFECTION (POURCENTAGE)
POURCENTAGE RÉEL
POURCENTAGE DU NOMBRE TOTAL DES FEUILLES
POIDS MOYEN DES FEUILLES
SURFACE MOYENNE DES FEUILLES
0.1 à 5%
2.7%
27.4%
475mm2
22.35mg
5.1 à 10%
7.5 %
26.2%
403mm2
19.5mg
10.1 à 25%
15.8%
29.8%
365mm2
17.6mg
25.1 à 50%
34.1%
7.9%
367.7mm2
16.8mg
50% et plus
65.5%
1.4%
334.1mm2
14.9mg

ALPINE RANGES
in south central British Columbia

A. L. VAN RYSWYK

La présente étude donne une définition des pâturages arides des montagnes du centre-sud de la Colombie-Britannique.

Celle-ci sert de base à leur évaluation pour le pâturage des animaux tant sauvages que domestiques.

The alpine rangelands of south-central B.C. have supported grazing animals since the retreat of the Cordilleran ice sheet, about 10,000 years ago. Wild goat, sheep, deer, horses and rodents commonly inhabit and graze these areas at various times of the year.

Since World War II, logging operations have provided easy access to many of the alpine rangelands where increasing numbers of domestic cattle are now grazing for two months or more each summer, and have replaced domestic sheep.

In south-central British Columbia these ranges are found above tree line in the mountains and highlands surrounding the interior plateau. The tree line varies from about 7,000 feet elevation near the Canada-U.S. border to 6,000 or less at about latitude 52°N.

Since little detailed knowledge about the vegetation or soil of these rangelands is available, the CDA Research Station, Kamloops, B.C., selected a restricted area for close examination, based on a reconnaissance soil survey. The area lies in the Okanagan range of the Cascade mountains (latitude 49°03′ and longitude 120°09′) and extends from 6,800 to 8,600 feet elevation.

It is in the rain shadow of the Cascade and Coast mountains and consequently has one of the driest climates of any alpine rangeland in south-central British Columbia.

The type and density of alpine vegetation varies markedly with the natural drainage conditions. Within the alpine portion of the area, 76 per cent is considered to consist of well to imperfectly drained types and 5 per cent of poorly to very poorly drained types. The remaining 19 per cent is made up of various rockland, rock rubble slope and snowbank types that are mostly barren of vegetation.

In our investigation, we found that about one-fifth of the area of the well to imperfectly drained types occurs between about 7,000 and 7,500 feet elevation (Fig. 1). It supports a continuous cover of tundra-like vegetation dominated by alpine sedges and grasses 4 to 6 inches tall that form a dense sod. The remaining four-fifths of this area occurs at higher elevations and has a discontinuous sedge-grass cover, resulting from various agents of natural erosion, and now exhibiting a mosaic pattern of vegetation in various stages of rehabilitation ranging from completely barren to continuous sedge-grass sod similar to that of the lower elevation (Fig. 2). Rehabilitation is slow

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Fig. 1. Alpine range near the tree line. Patches of forest communities occur in the continuous sedge-grass community. Erosion has occurred under the snowbank types and broken the volcanic ash mantel. Poorly drained types supporting good sedge and willow growth are seen in the middle ground. These are preferred by domestic livestock.

and depends on establishment of alpine species of dryas, willow and lupine to act as stabilizing pioneers and eventually allow the climax sedge-grass vegetation to dominate. Forage production on these types is less than 200 lb dry matter/acre per year. Domestic livestock rarely use this forage but wild sheep and rodents do to some extent.

Poor and very poorly drained types occur at all elevations but they are more common at the lower elevations and extend well below the tree line. Their vegetation is more lush, dense and taller than that of the well drained types and forage production may be 4 to 5 times greater. Sedges are the dominant forage species but grasses and many flowering forbs are present. Willow species up to 4 feet tall increase in density as drainage becomes poorer. Grazing by domestic livestock is confined almost exclusively to these poorly drained types. Deer often browse the willow shrubs in these areas.

We rarely encountered communities of heather-like vegetation, such as occur at or near the tree line of the moister coastal alpine ranges. Rather, the boundaries between alpine sedge-grass and adjacent forest communities are sharp, although quite sinuous, and frequently patches of one community occur within the other to form a complex mosaic. Forest communities consist mainly of spruce and larch with a sparse undercover of huckleberry, mosses and lichens. Few forage species occur. The trees at the tree line, and for at least 200 feet elevation below it, are stunted and of non-merchantable quality. Some trees are up to 400 years old.

Soils of the area are developed on local rock, weathered mainly by frost action to fragments ranging from boulders to silt. A thin mantel of silt-sized volcanic ash, 4 to 8 inches thick, covers the area. At the higher elevations where the sedge-grass cover is discontinuous, we found that this layer has been greatly disturbed by surface erosion and re-disposition by water and wind on steep slopes, by burial resulting from solifluction of saturated surface layers on gentle slopes. Solifluction is the slow flowage of a saturated layer of soil that develops at the surface during spring thaw before the frost is completely out of the lower layers because downward drainage is impeded. In the process surface turfy layers of soil may be 'rolled under' and buried by subsurface layers that 'boil up'. Indeed in this alpine area, solifluction may possibly occur over the relatively impermeable deeper horizons, starting down at about 2 feet. On exposed sites, frost heaving largely contributes to the disturbance.

A distinctive feature of the alpine soils of the area is the turfy surface. A horizon 1 to 2 inches thick resulting from the dense root mat of sedges and grasses. It is very high in organic matter and is underlain by A horizons 4 to 6 inches thick that are somewhat lower in organic matter. The organic matter content is considerably higher where the volcanic ash mantle has not been disturbed and this leads to a much higher water holding capacity which is reflected in a denser growth of vegetation.

Where volcanic ash is not disturbed, the alpine soils have strong brown B horizons underlying the A. These B horizons are acidic and high in iron and aluminum weathering products. They are very similar to those of adjacent forest soils. This would lead one to suspect that at least some of the alpine soils were once covered with forest vegetation. The presence of dead and decaying tree stems a few hundred feet above the present tree line tends to confirm this.

The lower horizons, beginning at about 2 feet, have high accumulations of silt that become so dense as to impede downward water movement. Much of the drainage water leaves the area by seeping laterally over these horizons.

Although natural erosion appears widespread on steep slopes and the higher elevations, removal of material from the area is very slow since it is redeposited within short distances. The water infiltration capacity of both the volcanic ash and the coarse textured debris weathered from local rock is very high and rarely does surface water accumulate to produce flood streams that carry away fragmented material.

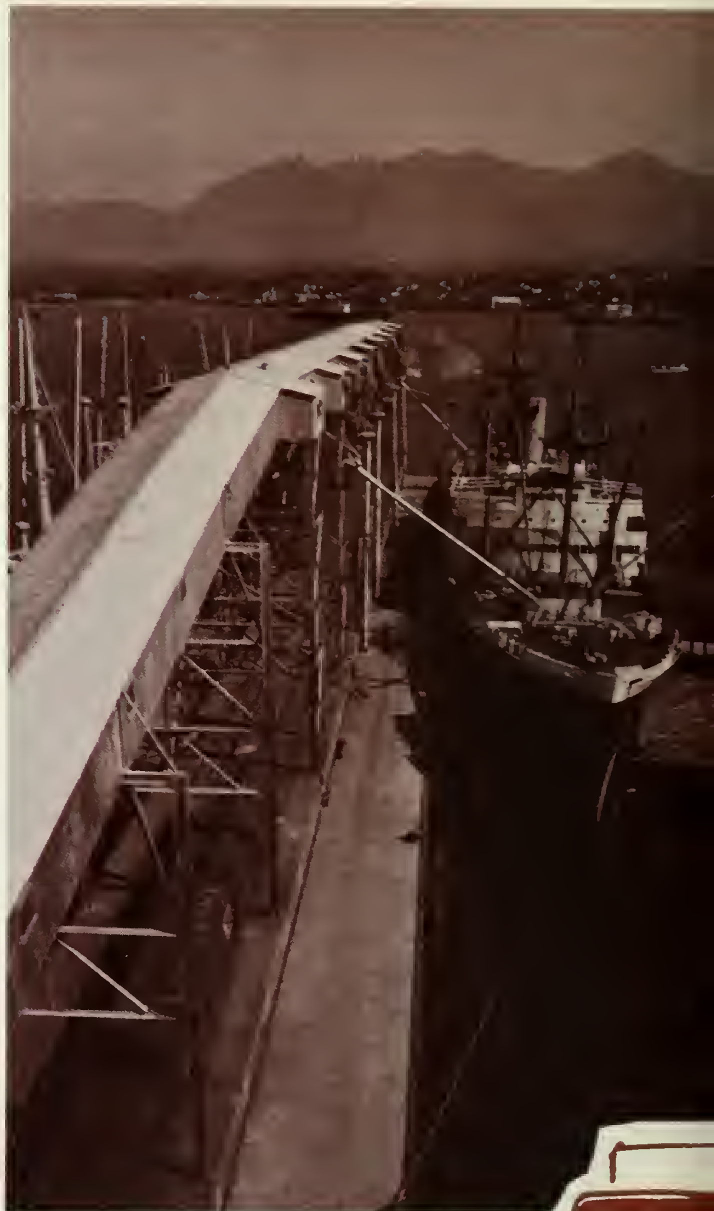
Only the poorly and very poorly drained types with continuous alpine vegetation produce enough forage to provide good summer grazing for domestic livestock. Should the area be allowed to become overstocked there is every likelihood that heavy use of well to imperfectly drained types would lead to accelerated erosion, especially on the steeper slopes.

Small herds of wild sheep and goats presently graze on some of these well to imperfectly drained types but apparently contribute little to current erosion. Deer browse on shrub of the poorly drained types and on some of the continuous alpine vegetation. The rodents, marmot and pika, are confined to special niches associated with excessively stony, broken rock or rock rubble slope types. Squirrels and chipmunks occupy forested types.

Our research has revealed that the best use of the alpine ranges appears to be for wildlife and summer grazing of domestic livestock. Within the study area, only 5 per cent seems suitable for domestic livestock. However, on most of the other alpine ranges that surround the interior plateau of B.C. the climate is moister and the proportion of poorly drained types that give good forage yields is considerably higher. Soils of these alpine ranges are ideally suited for water production because of their high infiltration and storage capacity and their ability to release it gradually over a long period.

This study gives us a better definition of dry alpine range types and provides a basis for comparison with other rangeland types, as well as for an evaluation of their potential productivity and stage of depletion whether it be due to natural erosive forces or to over-use. ■

GEOFFREY HISCOCKS



EAST-WEST

Le commerce est-ouest agricole canadien, qu'il soit national ou pour l'exportation, sera l'objet de modifications au cours des années 70. Celles-ci toucheront tous les secteurs de l'industrie agricole. C'est du moins ce qu'il ressort des prévisions de la Direction de l'économie du ministère de l'Agriculture du Canada.

The basic east-west trading pattern has been associated with movement of farm products *eastward.* Cheese from Ontario was an early export to Britain. Traditionally, wheat moved eastward to Britain and other parts of Europe. More recently it has moved both east and west, to China since 1960 and to the USSR in 1963-64 and 1965-66.

The development of agriculture in Canada has been from east to west. The earliest movement of people into Canada seems to have started with the Vikings from Scandinavia and at later stages more permanent communities were established in the Maritimes where people came to live and farm. Steadily, people moved westward into Quebec and Upper Canada and to the West.

TRADE PATTERNS CHANGE

But trading patterns have changed. Russia has all but stopped her wheat purchases and China has reduced hers. There has been a significant movement *westward* of wheat and other grains to Japan. This country with her phenomenal economic growth rate (8 per cent a year in the last decade) and expanding population (now over 100 million people) is an importing country of growing interest to Canada in east-west trading relationships. Besides this relatively new market of great importance, there are other special developments which will affect Canadian agriculture in the decade of the 1970's. They are:

- The difficulty of maintaining exports into Western Europe, with their protective agricultural policies and the stalemate in trade arising out of negotiations for a larger European Economic Community, to include Britain (and others).
- The continuing interest and uncertainty of the Russian and Eastern European wheat grain markets.
- The impact of changes in the prairies on agriculture in Canada, especially the impact of these changes on eastern Canada.
- The Canadian farm product and food market is now, more than ever, one market and a highly organized market at the retail, wholesale and processing level.

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IMPACT ON WESTERN CANADA

To look at these changes more closely, let's see what has happened to Canada's western agriculture in the last two years. Exports of wheat rose rapidly in the mid-1960's and at the same time world production increased. Then world exports fell, prices fell, and exports by Canada fell drastically. With smaller opportunities, Canadian producers have switched first to other grains (barley and oats), then to oilseeds (rapeseed and flaxseed), and then to livestock (first into hogs, and to finished cattle, then to expanded cow-calf operations and even to sheep). Not all of these are taking place at once and the most important impact at present has been in:

- Greater supplies of lower prices grains for feed—oats, barley and surplus wheat.
- A rapid increase in hog production in the West.
- A bidding-up of the price for feeder cattle.

IMPACT ON EASTERN CANADA

If we examine what impact this has had on Canada's eastern agriculture, we find that the turn-round in the western grain situation has brought a decline in the price of feed grains in Canada. While the eastern livestock industry could buy feed grains at lower cost, the west had them even cheaper. The impact on hogs in the east has not yet been fully felt but as the supply increases there will be some decline in price. Feedlot operators in the east have had to look harder and bid higher for feeder cattle not only from the usual western sources but also throughout the east and even south into the United States.

What this will mean for the future of eastern Canadian agriculture is a matter for speculation. According to economic studies, developments could take place along the following lines. World wheat markets, while moving out of the extremely low level of 1969-70, will not recover to the previous very high levels. Opportunities for expansion of grain crops will be centered on barley for feed and rapeseed for oil and meal. This means prices of barley on farms in the west at about 60 cents a bushel and at the low levels of last year in the east. Such prices will provide little incentive for higher production of grain products in the east, except corn, which can compete on the farm and in local areas because of its high yield.

Although lower prices will help producers of dairy products, broilers and eggs; cattle feeders and hog producers may find the competition from western products more severe. In the west, rapeseed production can be expected to increase rapidly and the long-term potential is excellent. Rapeseed crushing may not only increase in the west, as plants and equipment are expanded, but also eastern crushers could switch to rapeseed. This could have an impact on the price level of soybeans and on the large volume of imported oils and meals. In the livestock area, a rapid move into hog production (demonstrated in the west) is likely to continue as long as feed grain prices remain low.

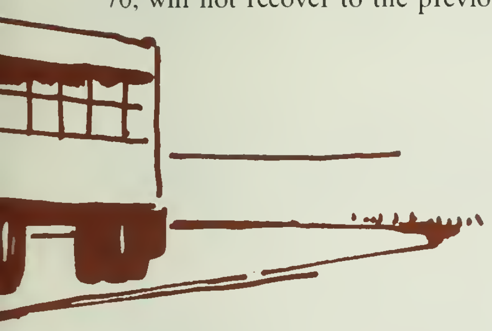
What about the impact on Canadian agriculture? Our studies indicate that the future will see less wheat, more feed grains, especially in the west, and more livestock from there, also. Thus, the emphasis will have switched towards livestock. This includes a policy assumption that feed grains can be moved into the east at competitive prices because, if feed grain prices in Canada are competitive with U.S. corn, then we can export feed grains and feed livestock competitively with the U.S.

However, some unanswered questions remain at the moment. For example:

1. Will more feed grains, rapeseed and forage for livestock utilize the 85 million acres of improved land in the west? If not, what happens to the excess land or the excess production?
2. Will the expansion of hogs lead to an even more severe hog cycle and bring low prices within two years?
3. Similarly, will low prices develop in beef production in three to five years as the current build-up of herds leads to a major increase in slaughterings?
4. What will be the effect of these events on the net incomes of producers?

There remain certain basic problems in Canadian agriculture, especially an imbalance of resources (land and people as well as farm products) in relation to demand, low and unstable net incomes, and unequal distribution of income.

The need for change has been set with the interest in the Federal Task Force Report on Agriculture. The movement and the desire for change is underway. There was never a better time than in the next 12 months to evolve and decide on these new policies. Opportunity is knocking to set agriculture on the road to profitability in the 1970's. ■



N CANADIAN AGRICULTURE

in cold grain

SURVIVAL OF THE RUSTY GRAIN BEETLE

L. B. SMITH

La survivance du cucujide roux dans les entrepôts à grain au cours de l'hiver est déterminée par l'intensité du froid auquel ils sont soumis et par la durée de l'exposition. On semble être en présence d'une certaine acclimatation.

The rusty grain beetle is well known as a major insect pest in stored grain in the Prairie Provinces. Nevertheless, people concerned with grain storage are not certain how these insects survive during the winter months. To store grain safely it is important to know how long rusty grain beetles can survive in cold grain, i.e. grain that experiences the normal cooling during the winter. Recent studies at the Canada Agriculture Research Station, Winnipeg, have revealed facts regarding the conditions that favor the survival of these insects. Their survival depends on two factors (1) the lowest temperature they are exposed to and (2) the length of time they are exposed to low temperature.

Before discussing the conditions of survival of cold further, let us briefly look at the life history of the rusty grain beetle. There are four stages in the life cycle, egg, larva, pupa and adult. The eggs are laid under loose pieces of the seed coat of the kernel, where they must be wedged-in firmly, since they have no sticky material to hold them in place. The adult lays eggs at temperatures between 68 and 104°F. The maximum egg production occurs on kernels of 16-18 per cent moisture content. The larva feeds on the germ of the kernel, usually only one larva to a kernel. The pupa is formed in the space in the germ eaten by the larva where it has maximum protection from predators. The life cycle is completed in about a month at optimum temperatures of 85 to 95°F but can take as long as 3 months at 70°F. The adult feeds on exposed germs and can live about 8 months at 75 to 85°F. Adults crawl freely among grain kernels and are usually found near the floor of those granaries which contain grain.

Most insect species that survive a Canadian winter have one stage that is specially adapted to escape death from freezing. To determine the cold hardy stage or stages of the rusty grain beetle, adults, pupae, mature larvae, first instar larvae and eggs were taken

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from cultures at 85°F. and placed at temperatures of 10, 20 and 35°F. The survival of all stages decreased as the temperature decreased, as expected, but the adults and mature larvae were consistently more resistant to cold than the pupae, first instar larvae or eggs (Table 1). Therefore, it seems likely that rusty grain beetles survive winter conditions in a granary as mature larvae or as adults.

It was interesting to note that the most cold hardy stages were also the most mobile.

The question next arose of whether these stages survived the cold weather by being able to find locations in which the temperatures remained above freezing or by being able to adapt to cold weather as some other insects do by a process known as acclimation. Accordingly, adults were placed at 60°F. for various periods of time to acclimate and then placed at 10°F. to determine whether their resistance to cold had increased. The result was that the longer the insects were held at 60°F. the longer they survived at 10°F. (Table 2). In other words, the adults were able to acclimate to some extent and would not need to find a location in the granary where the temperature remained above freezing to survive the winter.

In grain stored in granaries that hold about 1000 bushels, the temperature gradually falls during the autumn as the outdoor temperature falls. Since grain is a poor conductor of heat, the fall in temperature is greatest on the outside of the grain mass and least at the centre. The weekly fall in temperature in the center of the granary is not more than 5°F. per week. This slow fall in temperature gives rusty grain beetles sufficient time to acclimate to lower temperatures. Thus, when the temperature in the centre of the grain mass falls below freezing, the insects there are able to survive longer than if they had not been acclimated. The lowest temperatures at the centre of a 1000-bushel granary are between 10 and 20°F. at Winnipeg and remain this low for as long as 4 months. Therefore, to survive in an unheated granary the beetles must be able to survive at 10°F. for about 4 months. Certainly, not all adults could survive this period but from the results of our laboratory experiments it seems that a small percentage could. It is unlikely that all adults are killed by cold in unheated granaries in the southern part of the Prairie Provinces.

TABLE 1. EXPOSURE TIMES AT 1, 20 AND 35°F. REQUIRED TO CAUSE 50% MORTALITY OF DIFFERENT STAGES OF DEVELOPMENT OF THE RUSTY GRAIN BEETLE THAT WERE NOT COLD-ACCLIMATED.

Stage	Treatment temperature		
	10°F.	20°f.	35°F.
Adults	0.6 days	3.5 days	15.2 days
Pupae	0.3 days	1.5 days	8.8 days
Mature Larvae	0.8 days	2.7 days	8.6 days
First instar larvae	0.1 days	1.4 days	4.9 days
Eggs	0.5 days	0.6 days	5.3 days

TABLE 2. PERCENTAGE SURVIVAL OF RUSTY GRAIN BEETLE ADULTS AT 10°F. AFTER ACCLIMATION AT 60°F. FOR DIFFERENT PERIODS OF TIME.

Days of acclimation at 60°F.	Days exposed to 10°F.					
	3	5	9	14	22	28
0	0	0	0	—	—	—
7	—	33.5	30.8	19.2	—	—
14	—	79.5	41.4	40.5	—	—
20	—	—	—	76.3	76.5	50.8
28	—	—	—	74.6	73.3	60.8

With this knowledge, we can suggest methods of using our natural climate to control insects, particularly the rusty grain beetle, in stored grain. There are two possible methods, (1) to lower the temperature of the grain quickly or (2) to prolong the period spent at temperatures below freezing.

We saw in Table 1 that a fast drop of 75°F. killed 50 per cent of the population in about ½ day, whereas when the drop was 65°F. the time required to obtain the same kill was 3½ days; for a drop of 50°F. the time increased to 15 days. Thus the temperature drop would have to be large as well as quick. This would be difficult to achieve in farmstored grain except by turning the grain on a very cold day in winter. Even then not all the grain would be cooled to the temperature of the surrounding air, only the grain on the outside of the mass. Still this treatment would prevent breeding by the insects by lowering the maximum temperature in the grain and would cause the death of a large percentage of the population.

To prolong the period in which the temperature is below freezing, an aeration system could be installed to move cold air through grain. This would lower the temperature quickly and thus, increase the period that the rusty grain beetles would be exposed to freezing temperatures. Obviously, this would increase beetle mortality and reduce the residual population.

In summary, it is possible to use cold winter temperatures to *control* and *reduce* rusty grain beetle populations in stored grain, though it may be difficult to eliminate the beetles entirely. Grain cooling can be achieved most effectively by turning or by aerating soon after the outdoor temperature falls below freezing. The important facts to remember are that (1) the lower the temperature the less time it takes to kill rusty grain beetles and (2) in winter, the maximum temperature in the grain mass determines the survival of these insects, not the minimum outdoor temperatures. ■

farm credit in the 70s

M. E. ANDAL

> Les cultivateurs continueront à établir des fermes de plus en plus grandes et de plus en plus mécanisées afin d'en tirer des revenus plus élevés. En 1975, $150,000 de crédit auront à peu près la même valeur que $40,000 en 1964. Il se peut qu'on ait besoin d'un crédit spécial pour les agriculteurs à faible revenu. Les fournisseurs et les usagers du crédit devront être encore mieux informés.

Developments in farm capital and credit in the 70s will depend to a large extent on what happens in agriculture. During the 70s, we will no doubt see a continuation, if not an acceleration, of many of the changes which have been occurring in the past ten years. The changes having particular implications for farm capital and credit have to do with marketing, the organization of production, and farm finance.

There appears to be more attention being given to determining the nature and size of markets in considerations at all levels of production planning. Long-term market outlook suggests a substantial reduction of cereal crops from the past few years, a substantial increase in meat production, particularly beef, and an increase in some crops such as rapeseed, soybeans, sunflowers and grain corn. Co-ordination of production with market requirements can be facilitated with improved market research and dissemination of outlook information. It can also be facilitated by wider use of marketing boards and marketing quotas.

Farm production is being consolidated into fewer and more efficient farms. The farms will be larger, more highly mechanized, and will use more capital. The shortage of skilled labor, the cost-price squeeze, and a desire by farmers to increase incomes will continue to encourage the application of new technology and the use of modern equipment and machinery to increase farm size and efficiency. Farmers' desire for working hours and conditions more comparable to other sectors can result in more two- or three-man farms on some kind of joint-operator, partnership or

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incorporated basis. The upward pressure on farm land prices from the demand of urban people for farm land has important implications for farm capital requirements. The increasing concern with pollution of land, air and water, too, has implications for the economic development of farms.

The higher capital requirements of the larger and technologically advanced farms result in farmers seeking to use larger amounts of borrowed capital. They may also try to economize on their own and borrowed capital by greater use of rented land, buildings, machinery and equipment and by buying some services that they themselves have provided in the past. The pressure of inflation and relative shortage of loanable funds with their consequent effect on interest rates may also continue to be factors in farm finance in the seventies.

The exploitation of modern techniques of production marketing and financing will require well educated farmers with natural and acquired management ability.

These appear to be the main agricultural developments having significant implications for farm capital and credit in the seventies. Specifically, what do these developments call for in farm credit, if credit is going to facilitate the adjustments which farmers will be making?

Perhaps the most significant is the need for more capital and credit per farm. The present maximum loan limits under the Farm Credit Act of $40,000 for standard loans and $55,000 for supervised loans were established in 1964. Already the price increases in farm real estate have been such that $40,000 in 1969 would buy the equivalent of $26,000 in 1964. The 1966 census showed at that time there were more than 10,000 farms with a gross income of $35,000 or more, and over 12,000 farms with a capital investment of $150,000 or more.

The 1966 census data are already four or five years old, and when we are projecting ahead for the seventies, account must be taken of the rapid changes which have occurred and will occur. Projecting ahead to the mid-seventies, for example, the changes in farm land values which occurred from 1965 to 1969 would mean that it would take nearly $100,000 to buy what $40,000 bought in 1964. In addition to increases in land values, there have been substantial increases in sizes of farms and increases in the constant (non-inflated) dollar capital per acre in farms. Between the last two census years the average size of farm increased an average of 2.4 per cent per year. There was also a $0.70 per acre (1949 constant dollar) annual increase in capital per acre. Taking account of the above increased capital requirements would mean more than $150,000 to do the same kind of financing in 1975 as $40,000 did in 1964. This does not yet take into account projections made in various studies in Canada and the United States that farmers will on the average be borrowing about 30 per cent of their total capital requirements in 1980, compared with about 18 per cent at present.

Projections and forecasting are, of course, somewhat tenuous. It is difficult, for example, to see land price increases continuing at the pace of the sixties. Markets for some products have diminished and international competition is increasing. Nevertheless, even at much lower rates of increase in capital requirements than in the past, there is strong evidence of much larger credit requirements for the seventies.

Another implication for credit, of the agricultural changes envisaged for the seventies, is increased complexity and kinds of farms which seek financing. It was relatively easy to specify capital and credit needs for the typical single proprietor farm of the past. It is much more difficult to do so for the complicated organizational structure of many family farms which are now emerging. Further, the standard type of mortagage credit which has served well in the past may well require additional options to meet future requirements. This suggests that farm credit provisions will need to be flexible, enabling the providers of credit to meet the legitimate needs of farm borrowers. It suggests, too, the need for better informed suppliers of farm credit than in the past, so as to provide improved advice and so as to make better decisions.

Although the total number of farms has been declining and will continue to decline, the number of commercial farms will increase. Purnell and associates in the Canada Department of Agriculture estimated there would be 189,000 farms in 1980 with sales of farm products of $10,000 or more, compared with 95,000 in 1966. These are the farms which are heavier users of credit.

At the same time, there are many farmers who are not able or who do not wish to expand their operations in this way. Many of the lower-income farmers seek, and could probably wisely use, credit to make some improvements in their income and living standards. Although it is recognized that credit may be a relatively small part of program needs for this group of farmers, a special but essentially non-subsidized rural credit program could fill what appears to be a gap in this kind of credit.

The widespread improvements in standards of living, communications and knowledge have raised the aspirations of farm people to want to share more fully in the benefits of a modern productive economy. New technology in farm production and marketing makes this possible and affects the way in which agriculture develops. Appropriate credit facilities can assist in the fulfillment of the aspirations and in the achievement of the potentials created by this technology. The 1970s will provide considerable opportunities for farm credit to assist in the realization of the potentials. ■

ECHOES
FROM THE FIELD AND LAB

CANADA AGRICULTURE WINS TOP AWARD The American Association of Agricultural College Editors, in their 1970 Communications Critique and Awards Program, announced at the 54th AAACE Annual Conference held at Cornell University in July, that CANADA AGRICULTURE had received the highest award—an ACE Blue Ribbon which carries the 'Excellent' rating. Concensus of the judges was: "well done in all respects, displayed sharp layout, had an excellent choice of material, while writing and editing was clearly superior".

This quarterly was entered in the Periodical Class (for extension or research of combination), and was judged by James P. Lilly, Managing Editor, PRAIRIE FARMER, Lloyd E. Ver Steegh, Vice President, E. H. Brown Advertising Agency, Inc., Chicago, Illinois, and by William Aldrin, Art Director for the Brown firm.

Entries to the AAACE (ACE) Communications Contest are rated according to a detailed formula involving general impression (function, organization, originality, quality, practicality, article selection); copy elements (headline wording, writing, copy editing, style, written for intended audience); embellishment (layout, illustrations, versatility); and composition (printing).

Four other CDA Entries in different classes, including the Proper-Use-of-Pesticides Posters, won Red Ribbons (second highest award).

Forty-two states and 11 services of the U.S. Department of Agriculture were represented in this year's Contest while the Canada and Ontario Departments of Agriculture participated from this country.

CANADA AGRICULTURE REMPORTE LA PALME L'American Association of Agricultural College Editors (Société américaine des rédacteurs des facultés de sciences agricoles) a fait savoir au cours de sa 54e réunion annuelle que la revue Canada Agriculture s'était mérité la plus haute distinction de sa catégorie, soit le ruban bleu de l'ACE portant l'inscription «excellent». C'est en juillet, à l'université Cornell, à Ithaca dans l'état de New-York qu'a eu lieu la réunion cette année. L'opinion unanime des juges, émise dans le cadre du programme d'évaluation des publications et d'attribution des prix, se résume à ceci: «revue bien conçue à tous les égards, mise en pages agréable, excellents articles, rédaction de haute qualité et textes préparés avec grand soin».

La revue trimestrielle du ministère de l'Agriculture était inscrite dans la classe des périodiques consacrés à la recherche, au perfectionnement ou à ces deux activités que jugaient M. James P. Lilly, rédacteur gérant de Prairie Farmer, M. Lloyd E. Ver Steegh, vice-président de l'agence de publicité E. H. Brown Inc. à Chicago et M. William Aldrin, directeur artistique de la même agence.

Les échantillons soumis au concours de l'A.A.A.C.E. (l'ACE), réservé à la communication, sont jugés en détail d'après une formule qui tient compte de l'aspect global de la publication (fonction, organisation, originalité, qualité, utilité, choix des articles); de divers éléments qui entrent en jeu (expression des manchettes, rédaction, révision des textes, style, écrit au diapason du lecteur); de l'apparence (mise en pages, illustrations, variété); et enfin, de la composition (imprimerie).

Quatre autres réalisations du Ministère, dont des affiches sur les pesticides, se sont mérité des rubans rouges (deuxième prix).

Des représentants de 42 états et de 11 services du ministere de l'Agriculture des États-Unis, de même que des participants du ministère de l'Agriculture de l'Ontario et du ministère de l'Agriculture du Canada étaient en lice.

MANGANESE PROBLEMS Farmers in Prince Edward Island who, in their efforts to control potato scab, allow their soils to become very acidic, may encounter problems due to excessive uptake of manganese (Mn) by plants.

The risk is greatest when the soil pH drops below the 5 to 5.2 range. Also, manganese toxicity apparently grows worse when large amounts of fertilizer are added to soils in this acidic pH range.

Studies will be continued at the Canada Department of Agriculture Research Station, Charlottetown, P.E.I., so that useful recommendations can be developed for farmers. It's too early, at present, to tell farmers exactly how they could best combat the dual problem of manganese toxicity on the one hand and potato scab on the other.

Prince Edward Island currently produces more than 16,000,000 bushels of quality potatoes annually, all grown on acidic soils. The problem is that as soils become more acidic, large amounts of soil aluminum and manganese become available to plants.—R. P. WHITE, CHARLOTTETOWN, P.E.I.

POTATO VARIETY TRIALS Kennebec, as before, yielded highest in the 1969 potato variety trials carried out across Newfoundland. It gave both biggest yields and highest percentage of marketable potatoes.

Next highest yielder was Grand Falls, a Fredericton-bred variety, which produced good crops of attractive appearance. Although developed for the starch industry in New Brunswick, its high content of dry matter and good yield make it worth being grown as a quality table potato.

Two early varieties, Sable and Superior, were included in the tests. Sable gave a good yield of attractively shaped, uniformly sized potatoes. But Superior produced a very poor stand and yield because of seed piece decay. The result is similar to those of other tests which have shown Superior's high degree of susceptibility to rot diseases. If Superior is grown, seed pieces are treated with either maneb or polyram fungicide dust before planting.

The new wart-resistant variety Pink Pearl produced higher total yields than Urgenta, but about the same amount of marketable potatoes. The higher proportion of unmarketable Pink Pearl potatoes is due to the larger numbers of tubers set by the variety.

Chiefstain, a newly released variety from Idaho, gave very high yields in an initial small-scale trial at The Canada Department of Agriculture Research Station, St. John's West, Nfld. The potatoes are round, red and have shallow eyes.—K. G. PROUDFOOT, ST JOHN'S WEST, NFLD.

INFRA RED PHOTOGRAPHY USED ON WHITE BEAN CROP Blight and other diseases caused a loss of $20.65 per acre to white bean crops in the vicinity of Hansell, Huron County, Ontario, in 1968. This loss consists, simply, of a comparative measurement between the average top yield pertinent to a type of soil area and a poor yield found in the same area—it does not include the capital outlay by the producer involving labour, machinery and materials. Blight alone accounted for $9.80 per acre of the loss.

ECHOS
DES LABOS ET D'AILLEURS

These statistics were revealed when the aerial photography unit of the Economics Branch, Canada Department of Agriculture, using the color infra red process, photographed slightly more than 540 acres of the white beans in the Hansell district. The area covered was five square miles.

The data collected were analyzed to estimate loss to the farmer in the production of more than 840,000 pounds of seed, including total loss; loss due to non-producing but arable areas where the water table affected the seeding operations and early plant growth; loss relative to the percentage of reflection from the foilage or vigour loss; loss due to blight; other miscellaneous loss.

It may be possible in the future to use color infra red aerial photography to measure yield according to the amount of fertilizer used, and when the types of loss are relatively calculated.

Also, the photographic data show that there are excellent samples within the study area where further economic analysis of management practices may be done with respect not only to white beans, but to the associated crops of corn, winter wheat and vegetables.—L. E. PHILPOTTS AND V. R. WALLEN, OTTAWA.

IRON RICH B.C. CATTLE FEEDS Ninety-seven per cent of British Columbia forages and feed grains contain more than the recommended minimum iron content, according to a recent survey carried out at the Canada Department of Agriculture Research Station, Summerland, B.C.

A high iron content can interfere with the use of other scarce elements, and, because of the natural iron content in B.C. feeds, mineral supplements containing large amounts of iron should not be used.

Tests at the station over a four year period showed that 15 per cent of the feeds contained seven times as much iron as the recommended minimum of 30 parts per million.

The differences in iron content between legume hays, grass and sedge hays, corn silage, oat forage, and barley, oats and wheat were quite small.

The CDA research staff was assisted in the project by the B.C. Department of Agriculture and the B.C. Feed Analysis Service.—J. E. MILTIMORE, SUMMERLAND, B.C.

LE LAIT DE CHÈVRE Le lait de chèvre qu'on recommande souvent pour les bébés qui ont des troubles digestifs, est difficile à se procurer au Canada.

Si l'on en trouve, il provient souvent d'Europe où il est populaire comme breuvage et pour la fabrication du fromage. Le nombre des demandes de renseignements de la part de personnes intéressées à élever des troupeaux de chèvres va en augmentant.

Toutefois, trois troupeaux seulement, tous exploités par des femmes, sont inscrits au programme d'épreuve du Contrôle d'aptitudes fédéral-provincial.

La Société canadienne des éleveurs de chèvres comptait 325 chèvres inscrites dans ses registres l'an dernier, soit une augmentation de 70 sur les 255 de 1968.

Il faut qu'un éleveur de chèvres exploite un troupeau d'au moins 10 chèvres pour être inscrit au programme du contrôle d'aptitudes et adhérer à la Société canadienne des éleveurs de chèvres, fondée en 1917 pour favoriser les échanges de renseignements et l'amélioration des élevages.

Certains cultivateurs gardent une ou deux chèvres non enregistrées comme passe-temps ou pour les besoins de leur famille. Mais les règlements sévères qui régissent la production commerciale du lait cru ou du lait nature de toutes les espèces animales découragent la plupart des propriétaires de chèvres de rechercher ce qui ne peut être au mieux qu'un marché très restreint.—M. D. LAMBROUGHTON, CHEF DES INSPECTEURS DU CONTRÔLE D'APTITUDES AU MINISTÈRE DE L'AGRICULTURE DU CANADA, OTTAWA.

PLANT HARDINESS MAP Home gardeners who are planning to buy winter honeysuckle or hybrid tea rose plants, or perhaps a blue spruce tree, should first check the map of plant hardiness zones which is available without charge from the Canada Department of Agriculture. This brightly-colored map shows where different types of plants can normally survive the winter.

Canada is divided into ten zones of plant hardiness, each with a different color to help home gardeners to spot the rating for their area. As an example, the code number for winter honeysuckle is six and the color is yellow. A check on the map shows that winter honeysuckle will grow in southern Nova Scotia, southern Ontario and southern British Columbia. However, if a gardener in the Peace River region of Alberta or at Quebec City chooses honeysuckle for his garden, winter will likely wipe it out.

The map was developed from a complicated formula including the low winter temperatures, the number of frostfree days, summer rainfall rates, high summer temperatures and the amount of snow cover and wind. Plant hardiness was checked at the many research stations operated by the CDA from coast to coast, and the plants were keyed into the winter hardiness zones on the map.

The department has also published a companion booklet listing all of the ornamental trees that can be grown in each hardiness zone. It is called A Checklist of Ornamental Trees for Canada.

To obtain either the map or the booklet, without charge, write to: Information Division, Canada Department of Agriculture, Ottawa.

I.D. LAB FOR PESTS Identification of plant pests is the job of three members of the Canada Department of Agriculture's Plant Protection Division at Ottawa, Ontario.

Pest specimens sent to the division's identification laboratory may have originated anywhere.

About 80 per cent of the 2,500 specimens examined each year by the laboratory are found by CDA inspectors while checking luggage, imported plants and produce or other goods being brought into Canada. The remaining 20 per cent come from general nursery surveys and other investigations.

If a pest is sent to the laboratory, it means that the inspector who sent it in couldn't identify it. In the case of some plant diseases, a plant looks sick and he wants to find out why.

Once in the small laboratory, pest specimens are carefully housed in a huge refrigerator until they can be examined.

Often the time element is important, because the inspector who sent the pest in may be holding a shipment in quarantine, waiting for identification.

The laboratory workload is divided according to the pest types: disease organisms; nematodes; insects. A check is first made for the family, then the genus and then the species. If there are none, or few pest plants in a genus, it is dropped at that point, but if there are a number of pests, the laboratory carries on. The prime objective is to identify potential crop-damaging pests as quickly as possible.

LAMB PRODUCTION Favorable results of research concerning lambs, presently being conducted by scientists at the Canada Department of Agriculture, Fredericton, N.B., could lead to major changes in Canadian production of these animals.

The scientists are trying to increase efficiency of lamb production and net returns per ewe in the flock.

While the goal is not new, the approach is different.

Attention is being focused on the ewe. Rather than one lamb a year, researchers want her to produce two, three or more lambs each time she gives birth. And they'd like to have more than one crop of lambs per ewe each year. The physical limit would be two crops a year.—A. D. L. GORRILL, FREDERICTON, N.B.

DES METHODES NOUVELLES POUR DEFENDRE LES PLANTES CULTIVEES

En dépit des efforts déployés pour trouver des méthodes de remplacement, l'emploi de pesticides chimiques est encore le moyen le plus sûr de protéger les cultures. Il faut poursuivre les recherches pour que la lutte chimique soit employée à bon escient et que, partout où cela est possible, elle soit remplacée par des méthodes plus efficaces et moins dangereuses.

J. H. ROMAHN

What's the Future for Crop Protection? (see *Canada Agriculture*, Spring 1970 for a full account in English). Despite emphasis on alternatives to chemical pest control, the latter still remains the only really reliable method we have today. A strong research effort must be maintained to assure chemical control being used wisely, and, where possible, be replaced by safer, more effective methods it is argued.

Le mythe, qui faisait des pesticides la panacée contre les parasites et les maladies, vient de s'écrouler.

Un autre apparaît voulant que tous les pesticides soient des agents de pollution, responsables de toutes sortes de crimes.

Alors que l'ancien mythe les élevait aux nues, le nouveau les charge de tous les péchés de la terre.

«S'il existait une vérité absolue sur les pesticides, elle serait probablement située entre ces deux extrêmes» déclare M. W. B. Mountain, directeur de l'Institut de recherches entomologiques du ministère de l'Agriculture du Canada à Ottawa.

Les chercheurs savent qu'il n'est plus possible d'utiliser les pesticides sans restriction. On sait que ce sont des armes à double tranchant qui, s'attaquant aux ravageurs et maladies, s'attaquent aussi sans discernement aux parasites et prédateurs naturels, poissons et oiseaux.

Certaines attaques récentes contre les pesticides visaient plutôt à effrayer le public, qu'à le renseigner.»

Des faits, dénués de leur contexte, ont servi de base à des machinations partiales pour créer autour des pesticides une atmosphère lourde de doutes et de suspicion.

Les pesticides ne sont ni la panacée universelle, comme certains voudraient le croire, ni la source de tous nos maux.

J. H. Romahn, Rédacteur à la Division de l'information du ministère de l'Agriculture.

LE PASSÉ

L'emploi du DDT, premier insecticide moderne, s'est généralisé dans les premières années 1940. Comme tous les insecticides chimiques modernes, il n'avait absolument rien de commun avec les autres moyens de lutte connus.

Si, au début, on en connaissait les résultats, on en ignorait totalement le fonctionnement. Depuis, on a appris que le DDT—comme tous les pesticides modernes—attaque l'enzyme cholinestérase indispensable aux processus vitaux de tout insecte et de tout mammifère. Chaque pesticide attaque, de façon différente, cet enzyme relié au système nerveux. Ceci explique pourquoi les pesticides sont assez spécifiques.

Malgré tout, les insecticides modernes atteignent des insectes auxquels ils ne sont pas destinés. Au début de son emploi, l'homme ignorait le spectre d'activité du DDT. A l'heure actuelle, bien qu'il soit le mieux connu, on en étudie encore la portée.

On utilise aussi de nouveaux insecticides dont le champ d'action peut plutôt se comparer à celui d'une carabine qu'à celui d'un fusil de chasse. Leur action est plus localisée.

Pourtant, on connaît moins ces insecticides que le DDT, puisqu'on les emploie depuis moins longtemps et que, par conséquent, on n'a pas encore eu l'occasion d'en étudier à fond les effets sur le milieu.

Par exemple, la première fois qu'on a employé le DDT dans les vergers, les parasites s'attaquant directement aux fruits et ceux s'attaquant à l'arbre, que les entomologistes classent en parasites directs et parasites indirects, on été détruits.

Dans un verger, on ne peut tolérer que quelques parasites directs, mais les parasites indirects peuvent être tolérés en plus grand nombre. Le seuil de tolérance économique pour la pyrale de la pomme, qui attaque directement le fruit, laissant un ver dans le cœur, est d'une par pommier, tandis qu'on peut tolé-

rer jusqu'à 5,000 tétranyques rouges par arbre, puisqu'ils ne s'attaquent qu'aux feuilles.

Le DDT a neutralisé ces deux parasites, plus une variété d'autres insectes qui, dans certains cas, étaient les ennemis naturels des parasites en question.

L'abandon total de tout insecticide moderne entrainerait une pullulation de ravageurs dont les conséquences pourraient être catastrophiques. Personne ne peut en mesurer l'étendue avec exactitude, pas plus qu'il n'était possible de prévoir tous les effets directs et indirects de la découverte et de l'emploi généralisé des insecticides.

Conscients des dangers que comporterait l'interdiction subite de tous les insecticides et sachant fort bien que ces derniers ne constituent pas non plus une solution définitive et satisfaisante au problème de la protection des cultures, les chercheurs s'orientent vers la mise au point de meilleurs moyens de lutte faisant appel à de nombreuses disciplines.

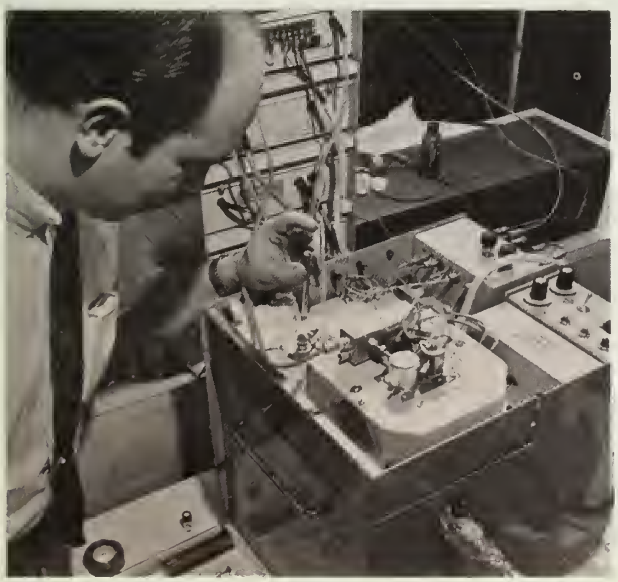
LE PRESENT

Alors que les chercheurs commençaient à dresser le bilan des effets secondaires des insecticides les mieux connus, les gouvernements modifiaient les anciens règlements et en créaient de nouveaux pour réglementer l'emploi des insecticides. Certains sont interdits. Comme le DDT était employé contre un grand nombre de parasites, ceci explique sans doute la publicité dont il a été entouré.

M. Mountain précise que «l'interdiction du DDT pourrait bien être un mal au lieu d'un bien, puisque les chercheurs le connaissent beaucoup mieux que n'importe quel autre insecticide, par le seul fait qu'il a été utilisé depuis plus longtemps. Etant donné les connaissances de base déjà acquises, il est évident que nous avons plus de chance d'en savoir davantage sur les insecticides en général si nous continuons nos recherches sur le DDT que si nous entreprenons de nouvelles études sur d'autres insecticides pris isolément.»

«Cependant, ce n'est là que le côté scientifique du

Injection d'un échantillon dans le combiné chromatographe à gaz—spectrophotomètre à masse pour l'identification certaine des résidus de pesticides.



problème, et d'autres facteurs sont entrés en considération lorsqu'on a décidé d'interdire l'emploi régulier du DDT sur l'ensemble du territoire canadien.»

En fait, bon nombre de ceux qui employaient du DDT, entreprises ou particuliers, s'étaient déjà tournés vers d'autres moyens de lutte avant même que ne soit lancé l'interdit. Toutefois, le grand public, lui, continuait à employer le DDT au lieu de le remplacer par autre chose.

Ces dernières années, en Ontario, ce sont les producteurs de tabac qui consommaient le plus de DDT: ils l'appliquaient pour neutraliser les vers gris. Le bassin hydrographique de la région intéressée est le lac Erié; mais des études ont révélé que les résidus de DDT sont beaucoup plus abondants dans le lac Simcoe que dans ce dernier.

M. Mountain en déduit que même le plus gros consommateur agricole de DDT n'est pas autant responsable de la pollution du milieu que ne le sont les ménagères et les propriétaires de chalets. Il ajoute:

«Peut-être ne sommes-nous pas disposés à renoncer à l'emploi de certains insecticides si c'est une question de choix entre se bien nourrir et jeûner. Mais s'il faut choisir entre la pollution due aux insecticides et les insectes incommodants (tels que les moustiques qui attaquent à la tombée du jour), la réponse risque d'être fort différente.»

Les méthodes de lutte autres que les produits contenant du DDT font l'objet d'un renouveau de recherches.

Lors de l'introduction du DDT et d'autres insecticides du même genre, bon nombre d'entomologistes ont commis l'erreur de pousser un soupir de soulagement, pensant que le problème était résolu une fois pour toutes, alors qu'ils n'auraient dû voir là qu'un répit dans la course de longue haleine qu'est la recherche de méthodes améliorées de défense antiparasitaires.

Les chercheurs combinent maintenant procédés anciens et nouveaux comme moyen de remplacement dans les vergers, par exemple.

Dans la vallée de l'Okanagan, en Colombie-Britannique, des chercheurs du ministère de l'Agriculture du Canada essaient de neutraliser la pyrale de la pomme par la technique du mâle stérile. En gros, cette technique consiste à introduire dans la région à traiter un tel nombre de mâles stérilisés que les femelles n'aient aucune chance de s'accoupler avec un mâle fécond. Elles pondent alors des œufs stériles qui ne peuvent éclore.

Jusqu'à présent les essais ont été satisfaisants. Cependant un programme basé uniquement sur cette méthode de lutte reviendrait très cher en raison du coût d'élevage des mâles stériles et de leur diffusion à l'endroit voulu. Cette technique serait satisfaisante dans une région aussi fermée que la vallée de l'Okanagan, qui est entourée de montagnes; mais à découvert, des mâles féconds venant des environs pour-

Un scientifique analyse les données du chromatographe à gaz.

raient s'y introduire. En d'autres termes, cette technique peut être efficace dans la vallée de l'Okanagan, mais pas du tout dans les vergers de l'Ontario ou du Québec.

Voilà pour les pyrales de la pomme et de la poire dans la vallée de l'Okanagan. Mais il reste encore trois sérieux ravageurs des poires. Contre deux d'entre eux, une maladie fongique et un insecte, on aura recours à un fongicide. Ce produit chimique antiparasitaire n'est pas toxique pour les mammifères et pratiquement inoffensif pour les poissons, les oiseaux et autres animaux et pour l'homme.

Grâce aux mâles stériles de la pyrale qui apportent une solution au problème causé par cet insecte, l'arboriculteur n'a plus à pulvériser de puissants insecticides chimiques. Ce qui signifie également que le nombre de prédateurs et de parasites pour neutraliser le quatrième ravageur–un acarien parasite indirect qui s'attaque aux feuilles du poirier–sera plus élevé.

Cette méthode de lutte antiparasitaire est dite intégrée car elle intègre des moyens naturels à des moyens de lutte chimique et biologique (mâles stériles).

«Il faudra au moins six ans pour mettre au point cette lutte intégrée pour les poiriers,» dit M. Mountain. «La conception de programmes de lutte intégrée est une tâche longue, ennuyeuse, astreignante et décevante. De tels programmes n'apparaîtront certainement pas du jour au lendemain pour toutes les cultures du Canada. Et même si on y parvenait un jour, seul un agriculteur exceptionnellement bien formé et intelligent pourrait appliquer cette technique correctement.

«Si on a, par exemple, recours à la lutte intégrée pour neutraliser un ravageur direct en ne pratiquant qu'une pulvérisation au lieu de six, on devra probablement agir sur la troisième génération au cours d'une période de trois jours de son cycle évolutif. La personne qui applique cette méthode doit être capable non seulement de situer la troisième génération du ravageur en question, mais aussi d'appliquer la quantité exacte d'insecticide nécessaire pendant ces trois jours où l'insecte est vulnérable.»

Le problème des pommiers est encore plus compliqué en Ontario et au Québec que celui des poiriers en Colombie-Britannique car il est causé par huit ravageurs. Et il est évident qu'il sera beaucoup plus difficile d'employer des méthodes de lutte intégrée contre huit ravageurs que contre quatre.

La Direction de la recherche du Ministère étudie pourtant ce problème à tous les points de vue, depuis la création de nouvelles variétés résistantes à la tavelure du pommier jusqu'aux expériences de lutte contre la pyrale à l'aide de mâles stériles.

Des sociétés de produits chimiques ont déjà trouvé de nouveaux types de pesticides, dont certains n'ont pas à être pulvérisés sur le feuillage car ils circulent à l'intérieur des plantes; on les appelle insecticides endothérapiques ou «systématiques». Seuls sont touchés les ravageurs qui s'attaquent à la plante ou à ses fruits. L'industrie est à la recherche d'autres insecticides de ce genre qui seraient plus efficaces tout en restant inoffensifs.

L'une des solutions les meilleures et les plus inoffensives réside dans la création ou la sélection de nouvelles variétés qui résistent à un ravageur donné. Il existe déjà du blé résistant à la rouille, des tomates résistantes à la flétrissure, de l'orge résistante au charbon, du blé résistant au cèphe et des pommiers résistants à la tavelure.

L'AVENIR

M. Mountain déclare que les chercheurs du Ministère vont continuer à diriger tous leurs efforts sur les moyens du lutte dépourvus d'effets secondaires nocifs comme ceux des pesticides chimiques modernes.

Les principales méthodes qui font, à l'heure actuelle, l'objet d'études au Canada et dans d'autres pays sont les suivantes:

- Produits chimiques exerçant un effet attractif ou répulsif, y compris les substances sexuelles (phérormones). Il s'agit de trouver le produit chimique qui attire un insecte mâle vers une femelle ou inversement, et de le fabriquer en quantités suffisantes pour attirer, repousser ou dérouter les insectes en question. L'attractif sexuel femelle serait placé dans une boîte contenant un poison qui tuerait l'animal qui se serait laissé attirer. On suppose que les insectes sont attirés par certaines plantes de la même manière; la pyrale, par exemple, est plus attirée par un pommier que par un érable. Si on parvenait à découvrir la substance qui influence le choix de l'insecte, il deviendrait alors possible d'éloigner les insectes des aliments et des plantes nourricières de l'homme.
- Pulvérisations d'hormones. Des chercheurs essaient d'isoler les hormones des insectes pour étudier le rôle de chacune d'entre elles. L'une des expériences en cours au Ministère porte sur les hormones juvéniles

et sur celles de la mue. Lorsque l'équilibre entre ces hormones se modifie, l'insecte passe par les différents stades de son cycle évolutif. Pour passer du stade larvaire à celui d'adulte, il ne faut pas d'hormone juvénile. L'homme pourra peut-être la reproduire par synthèse et s'en servir pour arrêter le cycle évolutif des insectes.

• Ondes radio. Les insectes «sentent», en captant des molécules de l'odeur attractive, dans les espaces de leurs antennes. Une fois dans ces espaces où elles entrent comme une clé dans une serrure, ces molécules vibrent à une très haute fréquence. Les chercheurs pensent que s'ils la connaissaient, ils pourraient induire les insectes en erreur en plaçant dans l'endroit à traiter un poste émettant sur la même fréquence ce qui dérouterait les insectes à un tel point qu'ils ne s'accoupleraient plus.

• Eclair lumineux. Certains insectes se préparent pour l'hiver en automne dès que les jours raccourcissent. Il semble que leur horloge biologique soit réglée sur la durée du jour. Si cette alternance de lumière et d'ombre est modifiée, l'horloge ne fonctionne pas, l'insecte ne se prépare pas pour l'hiver et le froid le tue. Certains chercheurs pensent pouvoir utiliser, pour lutter contre les ravageurs, un éclair lumineux produit en pleine nuit juste à l'époque où le ravageur en question règle son horloge biologique.

• Maladies des insectes. Des chercheurs étudient les divers champignons, bactéries et virus qui s'attaquent à tous les ravageurs du Canada. Ils s'intéressent surtout aux bactéries et aux virus qui déciment ces ravageurs sans porter atteinte aux autres formes de vie. Ils ont déjà trouvé plusieurs virus et au moins une bactérie qui semblent pouvoir avantageusement remplacer les insecticides chimiques.

Il y a au moins 80,000 espèces d'insectes au Canada, ils sont vigoureux et bien adaptés aux conditions de vie de ce pays. Ils sont, en grande majorité, utiles et d'un grand secours dans la lutte contre les ravageurs.

M. Mountain pense qu'on ne parviendra jamais à faire disparaître tous les insectes ravageurs, qu'il ne faut pas pour autant se décourager, mais au contraire redoubler d'ardeur dans les recherches.

Au ministère de l'Agriculture du Canada les recherches portent sur:

• L'écologie, à l'Institut de recherches de Belleville (Ont.). Elles sont orientées vers la lutte biologique et intégrée—par exemple, l'importation contrôlée d'insectes pour parasiter les ravageurs du Canada.

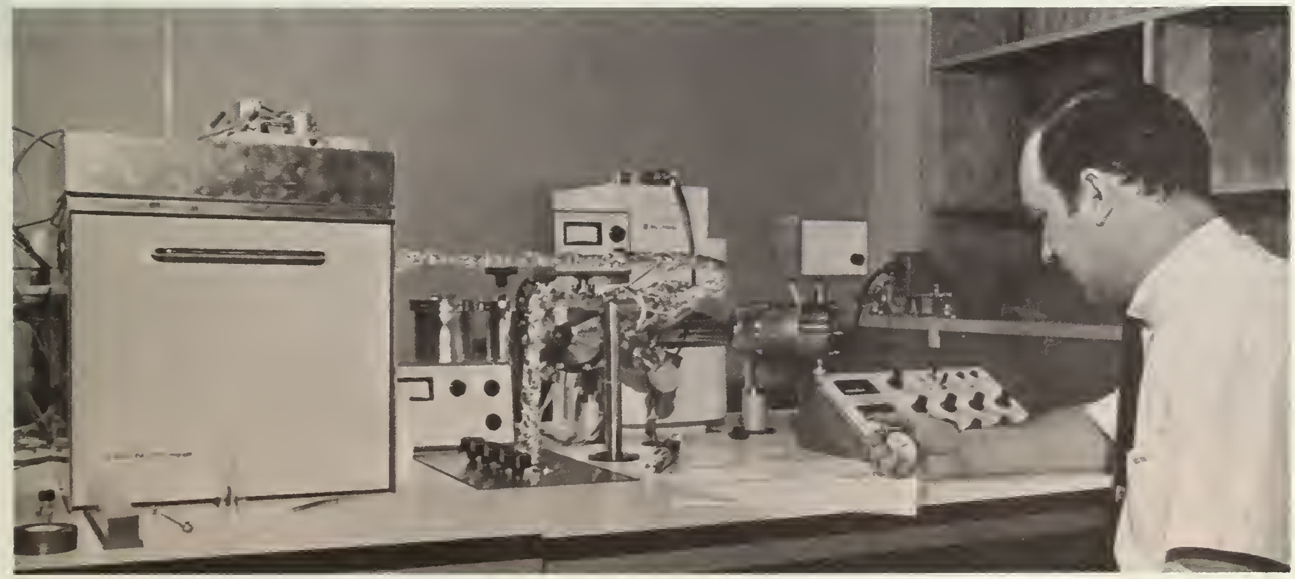
• La chimie, à l'institut de recherches de London (Ont.). Celles-ci s'échelonnent depuis les études sur les résidus des pesticides jusqu'aux recherches sur la chimie des insectes en passant par l'étude de la façon dont les produits chimiques tuent les insectes.

• Taxonomie et physiologie à l'Institut de recherches entomologiques d'Ottawa où les chercheurs identifient les insectes dont ils étudient la physiologie. Après quoi ils peuvent élaborer un programme de lutte intégrée tel que celui qui est actuellement en cours contre le criocère des céréales – et contribuer à éliminer un insecte avant qu'il ne cause trop de ravages.

• Etudes diverses dans les stations de recherches du Ministère d'un océan à l'autre. Elles portent sur les pesticides chimiques, la lutte intégrée, la lutte biologique, et même sur des recherches aussi fondamentales que celles qui sont faites sur les hormones des insectes. Chaque station s'occupe de la création ou de l'essai de nouvelles variétés de plantes cultivées. Le programme de recherches appliquées touche toutes les cultures commerciales du Canada, et l'un des principaux objectifs des programmes d'amélioration génétique est d'introduire et d'accroître la résistance aux insectes et aux maladies.

M. Mountain conclut par ces mots: «Les pesticides chimiques ne sont pas la solution à tous nos problèmes et nous le savons si bien que nous faisons tout ce qui est en notre pouvoir pour les remplacer, partout où cela est possible, par des méthodes efficaces mais moins dangereuses.» ■

Ce combiné spectrophotomètre–chromatographe à gaz est le seul du genre utilisé au Canada pour la recherche sur les pesticides.



B. B. MIGICOVSKY

SCIENCE AND PUBLIC

Si la science peut nous permettre d'orchestrer notre propre évolution et celle de nombreux systèmes biologiques, il ne fait nul doute qu'elle doit se soumettre à la volonté des hommes. Cette soumission doit-elle être absolue ou relative?; de quelle sorte?; appliquée par qui? C'est l'essence même de la politique des sciences.

The power of science, which conceivably could enable us to control our own evolution and the evolution of many other biological systems, has led society to consider the question of control of scientific activity. There appears to be no doubt that a degree of control is needed. The burning question is how much? What kind? And by whom? That is, the substance of a science policy.

One of the difficult issues a science policy must face is how much effort to devote to so-called basic research, how much to applied or oriented research, and how much to development. Many people have contributed to this debate causing some confusion.

It is in the nature of people to be impressed by the simultaneous occurrence of events—so much so that correlation frequently signifies causation and we proceed to create policy on the basis of inadequate observations. For example, the development of high yielding grains, nuclear energy, and space exploration

Dr. Migicovsky is Director General, CDA Research Branch. This article is based on the convocation address he gave at Carleton University, Ottawa, Ont., May 22, 1970.

are prime examples of what controlled direction of scientific research can accomplish. Hence, it is argued that if we control, harness and direct all scientific activity, we could reap greater benefits in less time for less money. The flaw in this argument is that people are looking at the tip of the iceberg. Most of the scientific research from which evolved these exceptional accomplishments was undirected, unharnessed and uncontrolled.

If you trace back any accomplishment, such as rust resistant wheat, television, heart transplant, nylon fibre, antibiotics, the contraceptive pill, you will find that only a small part of the investigational effort, albeit expensive, was carried out under direction and control. Most of the information necessary for discovery arose from uncontrolled and untrammeled research effort on the part of a gifted individual or small group of individuals. In short, I know of no *original* scientific idea or concept that came from a committee, a board of directors, or a Director-General's office.

What this means to me is that Canada must have a science policy that can channel and direct effort into the extension of original ideas for effective development and at the same time encourage and enable generation of original ideas and concepts. This requires a flexible policy, because scientific research *cannot* be arbitrarily placed into 'basic', 'applied', and 'developmental' categories.

Any attempt to define the terms 'basic' or 'applied' with respect to research leads to a semantic jungle. Research, in my opinion, is a spectrum of activity, at one extreme of which there is no way of predicting whether or when the information will be used—for good or evil. At the other end of the spectrum, there is very little doubt as to how, whether, or when the information will be used. At some place along this spectrum, we can begin to make predictions with respect to the use of the information. At this stage, we can begin to think in terms of control and organized direction. For example, research work in cell biology has led to experiments in cell culture and cellular fusion. We can now conceive of the possibility of species synthesis. The basic research becomes applied when we can routinely synthesize a new species of plants by an established technique. Further exploitation of the technique leads to 'developmental' research.

The pay-off, of course, is in the last experimental project—at the end of the spectrum, one that is easiest to sell—but I sincerely hope we do not adopt a science policy that makes it difficult to support the 'first' experiment, at the start of the spectrum where no pay-off is as yet visible.

COST/BENEFIT RATIO

Another policy issue of some concern is the use of the cost/benefit ratio in deciding the kind of research which merits support. Too strict an application of this concept could force research into short-term project areas and stifle imaginative activity which could lead to worthwhile development. If this concept had been used in the past, many projects which formed the basis for important discoveries would never have been sanctioned.

In Canada, we are in the midst of debate. It is gratifying that the Government of Canada has pre-

POLICY

cipitated the issue of a public policy with respect to science. My particular interest is the role that scientists will play in the formulation of this policy and my fear is that the babel of voices arising from the ranks of science are such that decisions will be taken without the involvement of scientists.

It is obvious that with development of science and technology proceeding at an alarming rate, a hands-off *laissez-faire* policy is inadequate. It is essential that we organize to support and influence science in desirable directions and at the same time provide a climate favorable to imaginative research.

Any policy for science must take great care not to overdirect, not to overcontrol, and not to stifle the creative forces on which effective science depends. At the same time, a policy must enable decisions on what funds to supply and which fields of application or development to favor. These are important and delicate decisions. It is most gratifying to note that the Government is organizing through councils and committees so that it can obtain continuously the best scientific advice and judgment that is available—from universities, industry and government. Despite these good intentions, however, there are many pressures exerted which can influence a policy adversely.

I have referred to control by government and quasi government institutions. There is another form of indirect control exerted by a small but voluble sector of the public and the communications media. This control can be both helpful and desirable and at the same time hazardous and harmful. It can and does generate useful effort but it can also force the effort disproportionally into particular directions.

BEWARE OF HALF-TRUTHS

Although I appreciate the increased attention science is receiving in the communications media, I reject the use of the half-truth and the false inference, particularly where the whole truth is available and will suffice to support the legitimate appeal that is being made.

I have an inherent fear of the popular and 'honest' opinion that is based on ignorance or incomplete knowledge. I have an inherent fear of the zealous, self-appointed high priests who would knowingly and convincingly use the half-truth to achieve a particular and even desirable end. I have an inherent fear of emotion without reason which becomes hysteria that often precipitates policy decisions prematurely.

I do not question the virtue and rectitude of the appeals and heartily support them. Diseases must be eliminated, pollution must be prevented, racism must disappear, food must be wholesome and plentiful, and environment must not deteriorate. It is the tactic of the half-truth and the false inference that is used in promulgating these desirable objectives that is hazardous and harmful.

Our experiences with the half-truth and false inference during the 1930's and 1940's, particularly in the field of genetics, are still fresh in the minds of many, and lead me to strike a note of caution.

As a result of the recent publicity, the word 'pesticide' is a dirty word today. It is supposed to be responsible, in the minds of many, for destruction of the ecosystem or environment. What the public has not been told is that harmful viruses, bacteria, fungi, insects, vermin and weeds are as much a part of the same ecosystem or environment as pigeons, buffaloes, hawks, fish, wild flowers and man. This same ecosystem is not static but dynamic and undergoing constant change, and in order to ensure survival of a particular unit in that system, be it tree, insect, bird, fish or man, we frequently have to interfere with the existence and possibly the survival of another unit, be it virus, fungus, insect, bird or weed. Touch this system at any point and you influence it at another. A pesticide is one of many chemical compounds designed to influence the ecosystem to man's advantage—sometimes the design is not perfect.

It is indeed too true that scientists have made mistakes—mistakes made visible by use of hindsight. New products and processes in the past have not always been properly assessed and evaluated in the light of knowledge available today. Nevertheless, it would be sheer idiocy to judge science only by its mistakes and neglect the overwhelming positive accomplishments.

Certainly we must fight pollution on all fronts but it must not deter us from fighting famine and disease. Since people and pollution go together, all our efforts will be for naught if we do not deal successfully with controlling an ever-increasing population density.

If ever we needed a concerted interdisciplinary effort, one that makes the effort expended on other areas such as space travel fade into insignificance by comparison, we need it now to prevent the catastrophe of over-population and subsequent pollution, environmental deterioration, and large-scale famine.

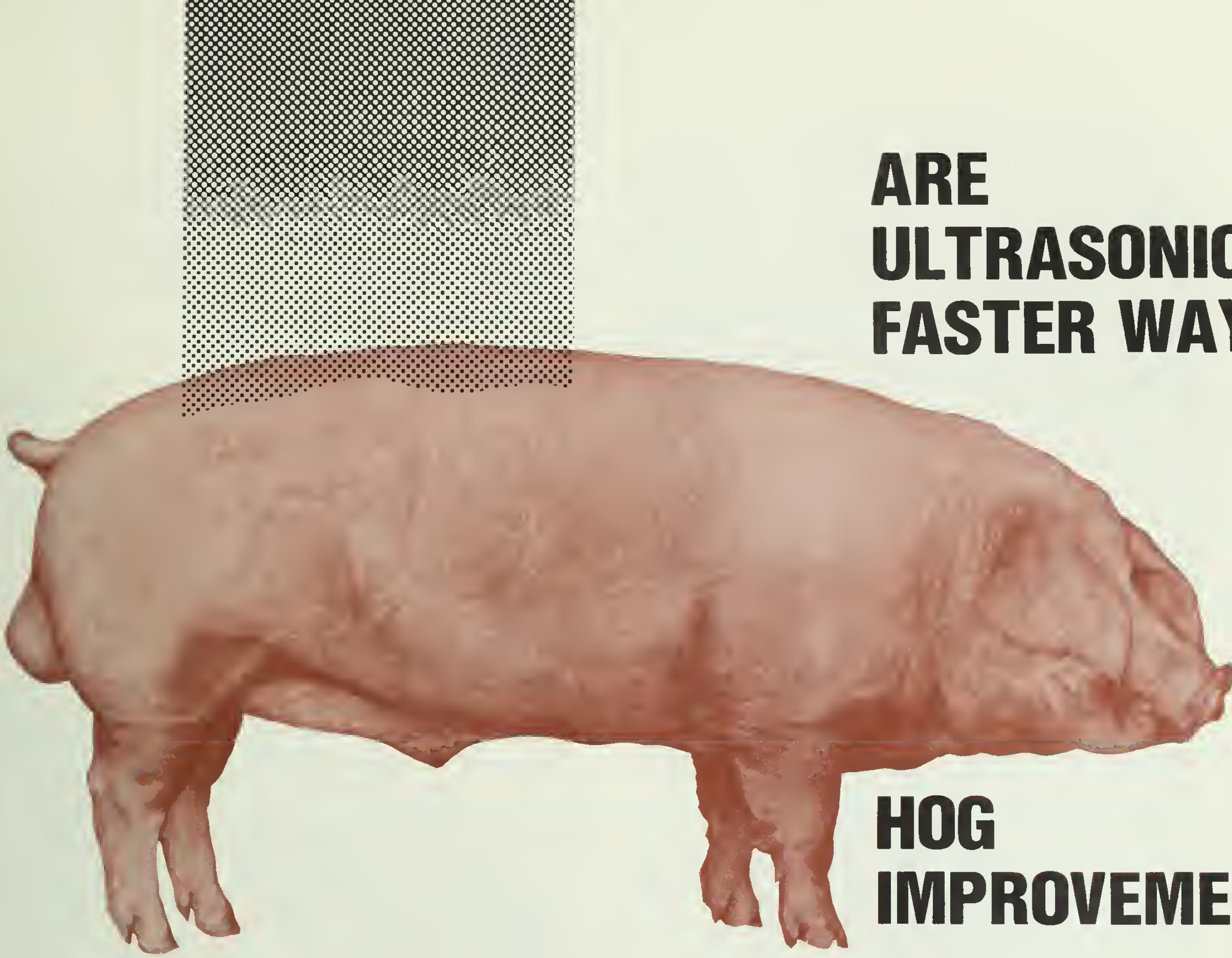
Nature has its own method of controlling species numbers and ensuring species survival. Hopefully, mankind can avoid nature's techniques of famine and lemming-like voluntary self-destruction.

We do not have the answers today and we won't have the answers tomorrow unless we expend every research effort.

"How much research effort" is a common policy question. The only answer is "enough to utilize all qualified investigators available in all branches of knowledge that can contribute to solutions of our problems of population growth, famine, disease, poverty, war and environmental quality".

If we were engaged in a war that is what we would do. It is time we declared war on these threats to our survival. ■

ARE ULTRASONICS A FASTER WAY TO HOG IMPROVEMENT?



D. W. MacDONALD

Le ministère fédéral de l'Agriculture a récemment fait venir d'Allemagne un appareil à ultra-son permettant de mesurer l'épaisseur du gras et du maigre des porcs. L'appareil doit être employé dans les stations de contrôle d'aptitude du Manitoba.

Performance tested stock is 'in' with the livestock fraternity today. Buyers want to compare one breeder's stock with another and are carefully scanning the scientifically measured data available on performance. Breeders without records of performance find themselves at a disadvantage because discriminating buyers want to be sure they are getting the best available.

In the case of swine, R.O.P. programs administered jointly by the Canada, and provincial departments of agriculture have been a standard, well accepted measure of performance. Under this scheme, the value of sires is determined at test stations or on the farm. It involves eight pigs, including two sibs from each of four sows, all from one sire. They are raised under uniform feeding and environmental conditions in the case of test stations. The sire is scored on the rate of gain, feed efficiency and carcass grade of his progeny. The disadvantage is the cost, the length of time required to get results, and the loss of potential breeding stock through slaughter. Progeny have to be slaughtered to record, or prove, the potency of parents to reproduce desirable performance characteristics.

More recently, sires have been selected on the basis of a backfat probe when the animal reaches a standard weight. Backfat has been shown to be a reliable indicator of the lean content of the carcass, and it is assumed that a lean hog will beget more lean hogs. Apart from the hog's reaction to the sharp probe, and the time required to take the measurement, the backfat is widely accepted as a practical method of assessing boards, under the boar performance testing program.

But the loin eye of a hog is also a measure of meatiness or carcass quality, and it is also highly heritable. There's a 60 to 70 per cent chance that a boar with a desirable loin eye will transmit the characteristic to his offspring. Until ultrasonic measuring devices came along, however, the loin eye, and other internal factors could not be determined without destroying the animal or its close relations. Ultra-

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sonic equipment is being investigated as an additional, more humane method of evaluating breeding stock.

Various instruments can send sound waves, beyond the pitch of the human ear, through living bodies without harmful effect. The Scanogram, for instance, has been tested extensively in the United States, following the lead of animal scientists at Cornell University. Sound signals returning from the animal are projected on a cathode ray tube, which when fitted with a Polaroid Land camera, record fat and lean areas permanently on film.

The Canada Department of Agriculture has recently introduced a unit from Germany. Designed originally to detect flaws in steel (up to 10 yards thick!), it bounces sound waves off various reflecting boundary layers, the angle of reflection being equal to the angle of incidence. At the boundary layers of the multi-layer tissue of an animal's body, however, not all the sound energy is reflected; only a certain part of it is bounced back and can be recorded. This makes it possible to measure the thickness of individual layers in an animal's body by calculating the double transit time. This is the time interval between transmitting and receiving. A barium-titanate oscillator serves at the same time as transmitter and receiver. The transit times which correspond to the layer of thickness of tissues measured are converted by a cathode-ray oscillograph and recorded on its screen in proportion to time.

The Krautkramer apparatus has the advantage of being lightweight and rugged. Operators can set the battery operated apparatus anywhere, independent of a power supply. And, very important, according to J. M. Mundy, in charge of R.O.P. Swine for the Canada Department of Agriculture, any man on the street can be an expert with the equipment after three weeks training. For the operator, it is largely a matter of knowing the basic physiology of the animal, and correctly relating signals on the cathode tube to the appropriate fat and lean areas. Sonic probes can check their results by comparing their readings on animals that are culled, with the actual carcass.

The apparatus measures in millimeters (20 to the inch) compared to one tenth of an inch with the conventional backfat probe. It can be imported at

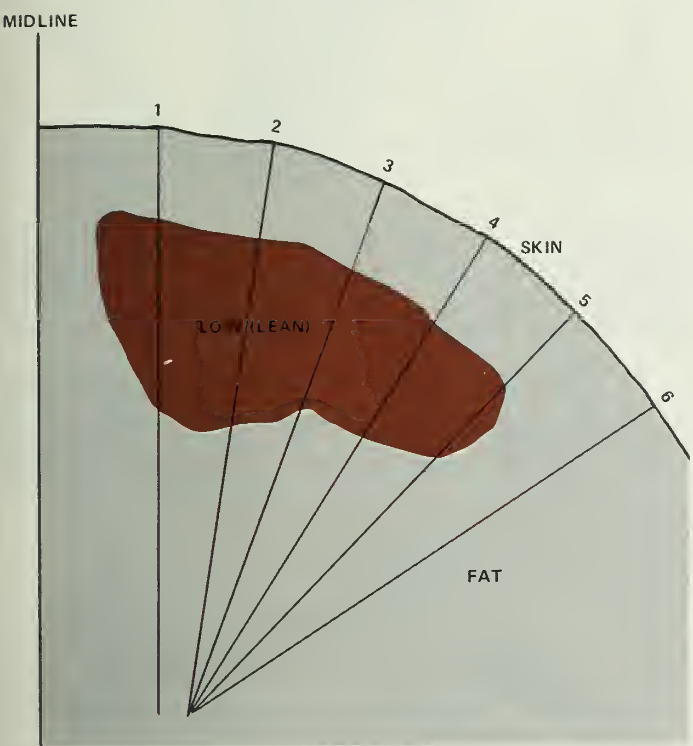
ULTRA SONIC DEMONSTRATION—REGINA WINTER FAIR—1970. READINGS ON THREE SELECTED PIGS

		Live Fat Probe				Actual Carcass Fat				Ultra Sonic Measurement				Loin Eye Area			Grade
Tattoo	Dr. Wt.	Sho.	Back	Loin	Ave.	Sho.	Back	Loin	Ave.	Sho.	Back	Loin	Ave.	Actual	Ultra Sonic	Difference	Index
X201	154	1.4	1.0	1.2	1.2	1.5	0.9	1.4	1.3	1.56	0.72	1.24	1.2	4.14	4.44	+.30	102
X121	158	1.2	0.7	0.8	0.9	1.0	0.8	0.9	0.9	1.12	0.56	0.72	0.8	4.60	4.96	+.36	103
X131	160	1.3	1.0	1.1	1.1	1.4	1.0	1.1	1.2	1.32	0.60	0.92	1.0	4.80	5.20	+.40	105

The interval between the time ultrasonic waves take to rebound from layers of matter (fat and lean tissues in the case of hogs) can be measured on the portable Krautkramer equipment.

Technician measures loin eye area of hog with portable ultrasonic equipment.

Ultrasonic measurements in millimeters (mm), taken at one inch intervals, centred on the midline, are diagrammed at right to show area of loin eye.



ULTRASONIC MEASUREMENTS

1		2		3		4		5		6	
mm.	in.	mm.	in.	mm.	in.	mm.	in	mm.	in.	mm.	in
20		20		20		22		22			
60		60		53		50		44			

a cost of about $3700. Operating costs are said to be negligible.

To take a reading on a hog, the hair is clipped, and SAE 30 oil applied to ensure airtight contact between the transducer and the skin. The backfat and loin eye can be measured in about ten minutes, or six hogs per hour, using the Krautkramer apparatus. This includes three readings (maximum shoulder, minimum loin and maximum loin) to get an average of the backfat thickness, and up to seven additional readings to measure the size of the loin area. The probe is placed half an inch from the center line of the animal, then every inch, up to six inches from the center to complete the sounding of the loin. From these readings, the boundaries of the loin eye can be sketched on paper and the size or area calculated.

A seven inch loin eye has been reported in the United States, J. M. Mundy points out. However, a breeder can set his own standard of, say, 4.5 square inches. Boars failing to meet this standard could be rejected as breeding stock. Mundy believes Canadian swine producers should be looking for a five square inch loin eye in their boars.

Thickness of backfat indicates the general fattiness of an animal. To be reliable, a fat measurement has to be related to a standard weight. Obviously that standard should be as close to market wieght (200 lbs) as possible. However, there is considerable merit in early culling and animal scientists are trying to correlate these factors to readings taken at a much earlier stage of maturity.

The great need is to test all the likely boars in the hog population in order to cull those of poor potential. It's largely a matter of volume. Last year, for example, 4000 boars were tested in Ontario by conventional methods. Many more will have to be tested if the best are to be selected for general improvement of the swine population.

Ultrasonic equipment gives researchers and testers another tool to use at test stations or in private herds to speed up the program. The question is not just a matter of accuracy, but if the innovation will significantly step up the rate of testing.

The Manitoba Department of Agriculture, in cooperation with the Canada Department of Agriculture has adopted the Krautkramer equipment for use at the R.O.P. Test Station at Brandon and throughout the province on the basis of its accuracy and convenience of handling. A group of 13 private breeders are testing it on a field scale in Ontario. And having introduced the German designed equipment to Canada, the Canada Department of Agriculture is in a position to help with the training of technicians who can develop the potential of the ultrasonic method of measuring live animals.

Because of its deep probling nature, ultrasonics in Canada will likely find its way into beef and sheep improvement programs as well. ■

INSECT PESTS OF PEPPERS

W. H. FOOTT

Les piments représentent une récolte de bon rapport pour de nombreux cultivateurs du sud-ouest de l'Ontario. Le présent ouvrage étudie la biologie et la lutte contre les trois principaux insectes ravageurs de cette culture, c'est-à-dire la mouche du piment, le puceron vert du pêcher et la pyrale du maïs.

Peppers are a valuable cash crop to many growers in southwestern Ontario, particularly in Essex County. At the CDA Research Station, Harrow, we investigated the biology and control of the three principal insect pests of this crop, namely, the pepper maggot, green peach aphid, and European corn borer.

PEPPER MAGGOT

Before 1956, the known distribution of the pepper maggot was limited to the United States in an area extending from New York and Massachusetts to Indiana and southward to Florida and Texas. In 1956, a small infestation of the maggot occurred in the field of peppers near Harrow and by 1961 had become a serious pest throughout much of Essex County. There is no evidence that it is established elsewhere in Ontario.

Our studies have shown that the maggot overwinters in the pupal stage in the soil, emerges as an adult fly in late June or early July, and deposits eggs in the walls of pepper fruits. On hatching, the larvae commonly bore to the inside of the fruits and feed on the spongy placental tissue. Approximately one month is required from the time of egg deposition until larvae mature and leave the peppers. It is an insidious pest because growers and consumers are usually unaware that a fruit is infested.

Based on our knowledge of the insect's seasonal history, it was evident that two important factors would have to be considered when devising control methods. First, because the egg is protected in the wall of the pepper and the larva within the fruit, it was imperative to find insecticides which would kill the adults before they could deposit their eggs. Secondly, since adult flies are seldom seen unless the plants on which they are resting are disturbed, an imminent infestation might escape detection. it would be necessary to treat pepper plants at a specified time each year rather than wait for evidence of adults in the field.

Field tests with a number of candidate insecticides showed that endosulfan and malathion applied at 0.5 and 1.5 lb. actual toxicant per acre, respectively, gave

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Correction

The captions on page 33 should read as follows:

Top left — Adult of pepper maggot.

Bottom left — Injury caused by larva of pepper maggot.

Top right — Horse nettle, the wild host of the pepper maggot.

Bottom right — Injury caused by larva of corn borer.

satisfactory control provided a minimum of four applications were made at weekly intervals starting in late June or very early July. Fortunately, the control measures have proved so effective that the maggot has been virtually eliminated from pepper fields. This high degree of success probably occurred because there is an interval of approximately one week between adult emergence and egg maturation and the flies are exposed to insecticides in treated fields throughout this long preoviposition period.

Infestations have continued in horse nettle, the maggot's wild host, but it is hoped that infested patches of this noxious weed will be eradicated in the near future.

GREEN PEACH APHID

The green peach aphid is an annual problem. We found this to be consistent on all varieties of peppers examined. The aphid reduces plant vigor, transmits virus diseases, and causes the fruits to be sticky and dirty by its deposition of honeydew. Although a number of effective aphicides are registered for use as sprays on peppers, we often receive reports of unsatisfactory control following their application. The first complaints are generally received in early August when growers state that a material which had given

in southwestern Ontario

satisfactory control earlier in the season is no longer effective and they suspect the aphids have become resistant to the chemical. usually, however, these initial reports coincide with the period of maximum buildup of aphid populations and the large numbers of aphids in treated fields reflect inadequate spray coverage on the lower surfaces of leaves rather than a change in the efficacy of the aphicide.

In a three-year study of the control of aphids at Harrow, we have found that one annual side dressing with a granular formulation of the systemic insecticide disulfoton controls aphids throughout the entire period that aphids are most prevalent in pepper fields. The chemical's usefulness is restricted at present because it cannot be applied within 90 days of harvest. However, residue analyses of fruit samples from treated plots (conducted by Dr. F. G. von Stryk, CDA, Harrow) show that there are no detectable amounts of disulfoton or its oxidation products 42, 50 and 60 days after treatment. A reduction in the required interval between time of application and harvest to 60 days would provide pepper growers with a valuable aphicide.

Top left—Adult of pepper maggot.
Bottom left—Horse nettle, the wild bost of the pepper maggot.
Top Right—Injury caused by larva of pepper maggot.
Bottom Right—Injury caused by larva of corn borer.

EUROPEAN CORN BORER

The European corn borer has two broods in southern Ontario, but it is only the second brood which infests peppers. Eggs are laid on the undersides of leaves and newly-hatched larvae move to the fruits where they bore into the cap area. As with the pepper maggot, there is often very little external evidence that a fruit is infested. Varietal susceptibility tests at Harrow have shown that Keystone Resistant Giant is particularly susceptible to attack. In 1966, 62.3 per cent of untreated fruits of this variety were infested and the five-year average for untreated fruit was 40.9 per cent. The borer has proved a difficult insect to control because of the long period during which eggs are deposited and the inability of many growers to obtain proper coverage of the plants with insecticides.

Whereas the present status of the pepper maggot is very favorable, and it has been shown that effective control of the green peach aphid is possible, corn borer infestations in peppers remain a serious problem. Improved methods for control of the borer will be sought at Harrow. ■

I. F. FURNISS

THE CHANGING DIMENSION OF CANADIAN AGRICULTURE

Des changements profonds ont marqué l'économie de l'agriculture canadienne dans les années 60. En 1969, par exemple, les importations de denrées ont excédé les exportations de produits agricoles. Ceci laisse présager que les années 70 verront d'autres changements importants.

The 1960's were a decade of continuing changes in the farm economy, principally in terms of the markets for Canadian farm products and the structure of the domestic industry. As we enter the 1970's, there is greater production, both in total and on a per capita basis, of food and feed grains in many parts of the world while the per capita demand for staples such as bread, potatoes and dairy products continues to decline in most Western countries. These changes have intensified the competition for available and potential markets. Although short-term changes such as crop failures at home or abroad could alter the outlook for Canadian agriculture, the longer-run outlook would appear to be a need for reduced emphasis on wheat and dairy production. Furthermore, a tailoring of the output of all commodities more in terms of the market demand of the North American consumer and of those overseas customers whose demand for Canadian farm products can be developed as stable outlets appears necessary if returns to resources are to be improved.

DIMENSIONS OF AGRICULTURE

These brief introductory remarks summarize the current marketing problems faced by the Canadian agricultural industry. Within that context, the main purpose of this article is to review the contribution of the agricultural sector to the economic health of the nation while recognizing that changing market demands and competition for markets will require important adjustments in output of Canadian farm products and the institutional framework of the industry. Some of the important dimensions and contributions of agriculture to the economy include the following.

- Although the agricultural census of 1966 counted 430,500 'farmers', there are only about 100,000 farms selling $10,000 or more of farm products annually. Operators of these farms are largely full-time farmers while operators of census farms with sales of less than this amount include a large number of part-time or small-size farming operations.
- About half of Canada's 276,800 census farms with annual sales of $2,500 or more produce either wheat

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or livestock as their main product. There are about 56,500 dairy farms in this group and about 30,000 farms producing other small grains than wheat.

• Eighty per cent of the total agricultural land lies in Western Canada. Most of it produces wheat, coarse grains, rapeseed and flaxseed. The total Canadian land area in farming amount to 174 million acres, 76 per cent of it owned by farm operators, 24 per cent rented.

• The total investment in Canadian agriculture is over $23 billion. That's about $43,600 per workers. The total investment breaks down into 69 per cent in real estate, 18 per cent in machinery, and 13 per cent in livestock and poultry.

• New capital formation in agriculture amounts to about a billion dollars a year—or almost eight per cent of Canada's total annual new capital formation. The federal government's Farm Credit Corporation is the main source of farm mortgage credit, accounting for about two-thirds of the total.

• In 1959, the farm labor force numbered 700,000 persons or 12 per cent of the total employed labor force. Today, the farm labor force numbers about 535,000 persons or seven per cent of a much larger total labor force. Since 1959, the hired farm labor force has been relatively stable in numbers and therefore an increasing proportion of the total, up from 16 per cent in 1959 to 18 per cent in 1969.

• Employment in the farm sector is somewhat higher proprotionately than the sector's contribution to Gross Domestic Product (G.D.P.). This has been characteristic of the industry, reflecting, among other things, the large numbers of part-time farming operations included and the somewhat lower average earnings in agriculture as compared with some other sectors of the economy. Agriculture contributed 4.1 per cent of Canada's $63.6 billion G.D.P. in 1968, or $2.6 billion of value added to the nation's total output of goods and services.

• Agriculture continues to be the leading primary industry in Canada ranking ahead of forestry, fishing, mining and oil wells.

• Canada's export trade in agricultural products was $1.211 million last year (1969)—about eight per cent of total exports. That compares to almost 20 per cent in 1959. In 1969, imports of agricultural products exceeded the value of agricultural exports for the first time in Canada's history. They reached a value of $1.246 million last year, or about nine per cent of total imports. Fresh and frozen pork imports were a significant item.

• Canada continues to run a trade deficit in agricultural products with the United States but a surplus with Britain and "all other countries" as a group. Imports are mostly out-of-season vegetables or products of a kind not grown in Canada while the main agricultural export continues to be wheat. Other exports include oilseeds, live animals, meat and meat products, and raw tobacco.

INTERDEPENDENCE WITH AGRIBUSINESS

Probably the most important single change in the Canadian agricultural economy in recent decades has been the growing interdependence of the farm and non-farm sectors, particularly for supplies and services but also for financing, processing and distribution. Thus, while employment in primary agriculture continues to decline, employment in the agribusiness sector is rising. A few points which illustrate this interdependence include the following.

• Employment in the areas of food and beverage processing, tobacco manufacturing, leather goods, implement and fertilizer manufacturing and the wholesale trade related to agriculture totals around 339,000 persons today. In the wholesale trade field, almost one-quarter of the persons employed owe their livelihood to the sale of farm products, food products or farm supplies. In addition, thousands of Canadians employed in the retail trade sector owe their employment, directly or indirectly, to the sale of the same classes of commodities and the provision of production, financial and other services to agriculture.

• Farm spending on gasoline, diesel fuel and lubricants is worth over $257 million annually. Shipments to dealers of new machinery and repair parts (at wholesale prices) last year (1969) totalled over $406 million. Fertilizer sales to farmers topped an estimated $200 million in 1968 but dropped to $160 million in 1969.
• Canadian farmers paid about $186 million in property taxes last year (1969). personal income taxes paid by persons classified as farmers represent about 2.2 per cent of total personal income tax payable.
• About 15 per cent of total rail freight is comprised of farm products. Almost one pound in four moving through the St. Lawrence Seaway is an agricultural commodity.

THE CONSUMER OF FARM PRODUCTS

The adjustments in farming during the past decade—fewer farmers, more capital investment per man and increased output have all added up to rapidly rising productivity (net output per man). Since the beginning of the 1960's, productivity in agriculture has been rising at an average annual rate of 6.6 per cent a year. This compares with a much slower growth rate for non-agricultural commercial industries in the same period of 2.3 per cent a year. Or, looking at it another way, one farmer today produces sufficient food, feed and fiber to support 40 persons (1967-69 average); in 1959 one farmer's work supported 27 persons. This increased efficiency in Canadian agriculture has benefited Canadian consumers much more than is sometimes realized. While food prices and consumer incomes, on the average, have both been rising, consumer incomes have generally increased at a more rapid pace than have food costs. The increases in prices received by the producer of farm products have been quite modest. Some of the facts which can be cited to support these observations include the following.
• Canadians today spend less than a fifth of their personal disposable income on food. That compares with almost 23 per cent in 1959.
• While the food component of the Consumer Price Index increased by 30 per cent from 1959 to 1969, or about 2.7 per cent a year, farmers' product prices increased by 21 per cent or 1.9 per cent a year; at the wholesale level the increase in prices of agricultural commodities was at the same rate.
• In 1959, an hour's work in the manufacturing industries would buy 3-1/5 dozen grade A large eggs or 1-7/10 pounds of sirloin steak. In 1969, an hour's wages would buy more than 4½ dozen eggs or 2-1/10 pounds of sirloin steak. Today an hour's wages at the specified rate will buy almost 4 pounds of creamery butter compared with 2½ pounds in 1959.

Wages in the manufacturing industries are used for this comparison because of the relative importance of this sector in terms of purchasing power. Employment in the manufacturing industries accounts for over 23 per cent of total Canadian employment. This is not to deny, however, that persons on fixed incomes find any price increases, food or otherwise, a hardship. But we must still conclude that without the gains in efficiency shown by the primary agricultural industry that cost of food materials would likely have risen much more in the past decade than the 21 per cent cited. Since the growth in productivity has outstripped the rise in farm prices by a significant proportion, this means that there has been a real reduction in the prices of farm products to consumers.

The accompanying table shows how relative food prices and wages in the manufacturing industries of today compare with those of a decade ago and they illustrate further the real reduction in food costs. ■

AMOUNT OF FOOD THAT AN HOUR'S WAGES IN THE MANUFACTURING INDUSTRIES WOULD BUY AT RETAIL, CANADA, 1959 and 1969

		1959		1969	
Food Item	Unit	Retail Price	Amount an Hour's Wages ($1.72) would buy	Retail Price	Amount an Hour's Wages ($2.79) would buy
		cents		cents	
Milk, fluid	qt.	23.4	7.4	32.2	8.7
Butter, creamery, first grade	lb.	69.6	2.5	72.2	3.9
Eggs, grade A, large	doz.	54.4	3.2	61.8	4.5
Beef, sirloin steak	lb.	101.0	1.7	135.4	2.1
Pork, rib chops	lb.	67.6	2.5	102.4	2.7
Flour, white, all purpose	lb.	8.4	20.5	12.1	23.1
Bread, plain, white, wrapped, sliced	lb.	15.2	11.3	19.8	14.1
Potatoes, No. 1 Table	10 lb.	48.9	3.5	58.8	4.7

Sources: Derived from data published in *Prices and Price Indexes*, Cat. No. 62-002, and *Earnings and Hours of Work in Manufacturing*, Cat. No. 72-204, both Dominion Bureau of Statistics publications.

CUTWORMS IN TOBACCO

CONTROL BY VIRUS DISEASES

G. E. BUCHER

On poursuit les recherches pour trouver un insecticide sans danger pour lutter contre le ver gris du tabac. Les chercheurs ont trouvé qu'un virus, utilisé seul ou en combinaison avec des bactéries ou de petites quantités de DDT, est aussi efficace que le DDT aux doses prescrites actuellement.

Cutworms, root maggots, and hornworms are the chief insect pests of tobacco in Ontario. Though several species of cutworms attack tobacco, the dark-sided cutworm, *Euxoa messoria* (Harris), causes the most damage.

In the light sandy tobacco soils along the north shore of Lake Erie, tobacco is king. Tobacco is planted in alternate years in rotation with rye, which is sown as a cover crop soon after the tobacco is harvested, to minimize erosion of the sandy soil. In tobacco fields rye is ploughed in the spring and the soil cleanly tilled to receive transplants from the greenhouse towards the end of May.

Dr. Bucher is a specialist in insect pathology at the CDA Research Institute, Belleville, Ont.

Fig. 1. Larvae of the dark-sided cutworm. When tobacco seedlings are planted in the field most of the cutworm larvae are about the size of the smaller larvae in the photograph.

Fig. 2. Mature cutworm larvae. The upper two have died from virus disease, the lower one is healthy.

The eggs of the dark-sided cutworm are laid in the soil in late summer, but do not hatch until the following spring. The young larvae eat the rye and moult two or three times, so that partly grown larvae, about the size of the smaller larvae in Fig. 1, are ready to attack tobacco seedlings as soon as these are transplanted in the field. Larvae can damage the tobacco plant in several ways; they may cut the stem at ground level and cause complete destruction of the seedling; they may injure the terminal shoot and stimulate the plant to grow suckers, which do not produce a good yield of commercial leaves; and they may eat the leaves.

Badly damaged plants are usually replaced within 10 days of transplanting. This increases the cost of production but prevents total loss. Damage inflicted after 10 days results in a loss of yield, as replacement transplants usually do not have sufficient time to produce a normal harvest of mature leaves before frost. As tobacco acreage is strictly controlled, any loss of yield is costly to the grower.

At present, no attempt is made to control cutworms in the rye crop, so that half of the available tobacco acreage serves as a breeding ground for the insect. Consequently, breeding adult moths (Fig. 3) are common in late summer and distribute numerous eggs throughout both rye and tobacco fields. Although the number of cutworms varies widely from year to year and from place to place, young larvae are a potential threat to the tobacco seedlings as soon as these are planted. Therefore, every spring, tobacco growers apply insecticides (usually DDT) to the tobacco fields before transplanting the seedlings to guard against the threat of cutworm damage.

As DDT is not rapidly broken down, its yearly addition to tobacco fields has resulted in considerable accumulation of residual insecticide in the soil. This increases the general problem of pollution and increases the danger that cutworms and other insects will develop resistance to insecticide. Thus, alternate methods of controlling cutworms are desirable even though present insecticidal practices usually give adequate protection to tobacco.

One of the alternate methods of insect control is the manipulation of natural enemies including diseases. Diseased larvae of the dark-sided cutworm have not been found naturally in tobacco fields. However, they are susceptible in the laboratory to three virus diseases originally isolated from *Euxoa ochrogaster* (Guenée), a related cutworm. Two of these viruses, a nuclear polyhedrosis and a granulosis, have properties that are useful for manipulation and therefore they were tested in the field.

Cutworm larvae are infected by eating food contaminated by viruses. The infective dose of virus varies from larva to larva and increases markedly as larvae develop. Thus, young larvae are very susceptible to infection and die rapidly, whereas mature larvae are more resistant and may live for a long period after being infected. Fig. 2 compares two larvae that have died from the nuclear polyhedral virus with one healthy larva of the same age.

Our first attempts to control cutworms in tobacco fields by virus diseases were with bran baits broadcast at the rate of 25 lb. of bran per acre before tobacco seedlings were planted. Control with baits containing virus was compared to control with baits containing DDT at the rate of ¼ to 1 lb. per acre and with those containing mixtures of virus and DDT.

The viruses did not prevent heavy damage to tobacco seedlings when applied as baits, even though from 40 to 90 per cent of the cutworm larvae later collected from the plots were diseased. Obviously, the cutworm larvae damaged the seedlings before the

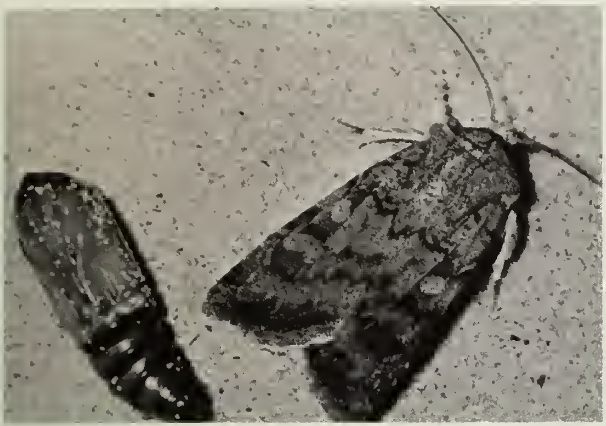

Fig. 3. Pupa and adult of the dark-sided cutworm.

virus diseases had time to limit their feeding or activity. Therefore, virus pathogens would have to be applied at least 10 days before planting the seedlings. This time element restricts the use of baits and suggests that virus diseases should be sprayed on the rye cover crop to infect larvae before the rye is ploughed and fields are prepared for tobacco seedlings. Baits containing the nuclear polyhedral virus mixed with ¼ lb. of DDT gave as good control of cutworms as those containing 1 lb. of DDT alone. This observation suggested that combinations of virus with small doses of insecticide might provide good control of cutworms, and at the same time reduce the amount of insecticide applied every year to the soil.

In 1968 the author, in cooperation with Dr. H. H. Cheng, of the CDA Research Station, Delhi, Ont., set up 24 field plots to determine if the nuclear virus would control cutworms when sprayed on the rye near the end of April, two weeks before the rye was ploughed and fields prepared for tobacco seedlings.

The virus treatments reduced damage to the tobacco plants in proportion to the concentration of virus used in the spray. In the control plots that received no virus, 44 per cent of the plants were completely lost and a further 29 per cent were heavily damaged. In plots that received the highest virus dose, only 5 per cent of the plants were lost and a further 5 per cent suffered light damage.

Also, in 1968 a large field plot was set up to determine if the granulosis virus would spread and control cutworms when sprayed on only a portion of the area. The virus was sprayed on the rye in a grid pattern of 50 spots to cover about ⅛ of the total area of the plot. The plot was commercially planted to tobacco and cutworm damage was compared with that in untreated plantings. At least 26 per cent of the cutworm larvae in the plot were infected with granulosis, but the virus disease did not adequately protect the tobacco seedlings from damage.

The tests in 1968 indicated that the nuclear polyhedrosis virus would protect tobacco from most cutworm damage when applied in high concentrations.

At present, the only practical method of producing a virus for use in control is by growing it in its specific host and extracting it from the dead and dying larvae. This process is expensive when compared to the cost of producing insecticides. To reduce cost, it is essential that virus be used in the lowest concentrations consistent with adequate control and that it be produced in the most efficient manner.

In 1969, further field tests were conducted by the same team to determine if lower doses of nuclear virus would control cutworms when used in combination with very small doses of DDT or with *Bacillus thuringiensis* Berliner, a bacterial pathogen of many insects that can be produced commercially at moderate cost. The figures on yield and grade of tobacco are not yet available but early records of loss of seedlings and damage are promising.

Another way in which cost might be reduced is by making large collections of cutworm larvae in the field and using them for virus production in place of insects reared in the laboratory. Because they spend most of their time in the soil, cutworms are difficult to collect in numbers. But methods developed in 1969 to concentrate cutworm larvae in specific soil areas will make the collection of large numbers of larvae feasible and economical.

Recent government restrictions on the sale and use of DDT for agricultural purposes are obliging farmers and research workers to investigate alternative methods of controlling insects. The interim solution will be the replacement of DDT by another insecticide that is more readily decomposed and thus does not build up large residues in the soil. The ideal solution would be the replacement of insecticides by specific insect diseases such as the viruses. These have the advantages of being harmless to man and other animals, and of not contributing to pollution. It is also possible that insect viruses could be established as self-perpetuating, permanent factors to reduce the numbers of an insect pest, especially where the crop (and the pest insect) is grown repeatedly on the same land, as is tobacco. As the main disadvantage of virus diseases is their present high cost, methods of reducing the cost are worthy of further investigation. ■

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COVER: Canada, (since 1969), has been participating in an international experiment on the European corn borer at the CDA Research Station in St. Jean, Que. Mr. M. Hudon, a biologist and author of the article on page 3 is seen here with Dr. M. Chaing making some field observations.

COUVERTURE: Depuis 1969, à la Station de recherches du ministère fédéral de l'Agriculture à Saint-Jean, P.Q., le Canada participe à une expérience internationale sur la pyrale du maïs. Monsieur M. Hudon, biologiste et auteur de l'article en page 3, examine ici des plantes de l'expérience en compagnie du Dr M. Chaing, généticien.

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